

The geology, mineralogy, structure and economic
aspects of the pegmatite-hosted Swanson
Tantalum Deposit, Tantalite Valley area, southern
Namibia

by

Laubser Pepler

(18P1796)

Supervised by

Prof. J. Harmer



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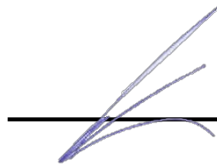
Rhodes University

Grahamstown

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Abstract

This study presents the geology, mineralogy, structure, and economic aspects of the recently explored Swanson Tantalum Deposit occurring within the Namaqua Sector of the Namaqua Natal Metamorphic Province, Tantalite Valley area, southern Namibia. It is an LCT-type pegmatite hosted (microlite-tantalite-tapiolite $\pm$ spodumene – lepidolite - zinnwaldite) tantalum deposit forming part of a highly localised sill-and-dyke swarm comprised of 15 shallow dipping and significantly mineralised pegmatites. This deposit forms part of the western portions of the regionally developed $\sim 1040 - 950$ Ma Orange River Pegmatite Belt (ORPB) which was locally emplaced syn-tectonically into competent host rocks in the core zone of the late-stage crustal scale transcurrent dextral, ductile to brittle-ductile D_4 Marshall Rocks – Pofadder Shear Zone (MRPSZ), where it crosscuts the rocks of the D_2 Lower Fish River - Onseepkans Thrust Zone (LFROTZ). A JORC Maiden Mineral Resource of 1.2 Mt @ 412 ppm Ta_2O_5 + 76 ppm Nb_2O_5 + 0.29 wt. % Li_2O (with an applied cut-off grade of 236 ppm Ta_2O_5 and a minimum thickness of 1 m) has recently been estimated for the deposit. The deposit is currently being advanced to feasibility stage with the aim of outlining economic Mineral Reserves. It currently hosts a globally significant and market-relevant “high grade – low tonnage” tantalum Mineral Resource.

Recent litho-structural mapping of this deposit has shown that its structural setting encompasses a locally developed lower strain extensional quadrant associated with the mega-scale shear zone bound competent mantle porphyroclast: the mafic-ultramafic Tantalite Valley Complex (TVC), or TVC megaclast. A succession of syn- D_4 MRPSZ-hosted granitic melts comprising earlier leucogranite intrusions and later mineralised pegmatites of the Swanson Tantalum Deposit have variably utilised this extensional structure. The earlier leucogranites have clearly exploited mylonitic foliations associated with the development of core zone of the MRPSZ, while the mineralised pegmatites have utilised later-stage shallow-dipping Riedel fractures developed within more competent host rock. The tantalum tenor of pegmatites comprising the Swanson Tantalum Deposit is clearly structurally controlled, with tantalum tenor increasing from NW towards the SE over relatively short distances, toward the TVC megaclast.

Although highly speculative without robust geochronological and petrographic investigation, field observations from this study highlights that the host rocks to the Swanson Tantalum Deposit, namely the mottled hybrid metagabbro (HMG), usually described as being syn- D_2 in age ($\sim 1200 - 1100$ Ma), may possibly be syn- D_4 in age ($\sim 1040 - 950$ Ma). If this is proven to be true, it may represent the earliest syn- D_4 melt known for the MRPSZ. The Swanson Tantalum Deposit area therefore represents a prime area for studying and potentially constraining the upper and lower age limits of the MRPSZ.

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1 Introduction

1.1 Background and rationale

In recent years interest in pegmatites and pegmatite-hosted mineral deposits have increased exponentially. Their natural endowment in rare metals such as Li, Rb, Cs, Be, Sn, Nb, Ta, Zr, Y, REE's and U, make them critical and strategic within a rapidly developing modern-day technology market (e.g., Schultz et al., 2017). A significant growth in the global demand of Li-based power storage technologies, Nb-based ferrous metal products, and Ta-based high temperature corrosion resistor capacitors has rejuvenated the study of and exploration for pegmatite-hosted deposits and the pegmatite fields in which they occur (Beurlen et al., 2014; London, 2016; Schultz et al., 2017). Consequently, several large-scale primary producers of spodumene ($\text{LiAlSi}_2\text{O}_6$), petalite ($\text{LiAlSi}_4\text{O}_{10}$), zinnwaldite ($\text{KLiFeAl}(\text{AlSi}_3)\text{O}_{10}(\text{OH},\text{F})_2$), lepidolite ($\text{K}(\text{Li},\text{Al}_3)(\text{AlSi}_3)\text{O}_{10}(\text{OH},\text{F})_2$), amblygonite ($(\text{LiAl}(\text{PO}_4)(\text{OH}))$), columbite-tantalite ($(\text{Fe},\text{Mn})(\text{Nb},\text{Ta})_2\text{O}_6$), microlite ($(\text{Na},\text{Ca})_2\text{Ta}_2\text{O}_6$), pollucite ($(\text{Cs},\text{Na})_2\text{Al}_2\text{Si}_4\text{O}_{12}\cdot 2\text{H}_2\text{O}$) and other rare metal-, industrial- and gem-mineral commodities associated with pegmatites have entered the global marketplace in the past decade (Beurlen et al., 2014; Doggart, 2019; London, 2016).

Not only have pegmatites experienced intense exploration and economic development, but they have also been subject to numerous geochronological and structural studies, often with highly significant applications in temporally constraining tectono-metamorphic events within poly-deformed orogenic terranes (e.g., Angombe, 2017; Anthonissen, 2010; Bial et al., 2015a; Buick et al., 2008; Cartwright et al., 1999; Clemens et al., 2017; Doggart, 2019; Lambert, 2013; Macey et al., 2015, 2017). For example, the migration and emplacement of melts and associated pegmatites through the crust, be it on a local or regional scale, has been shown to exhibit a positive feedback relationship with strain-localization, stress gradients and fracture permeabilities which develop (and change) during progressive tectono-metamorphism (Allibone et al., 1992; Aranguren et al., 1997; Arthaud, 1993; Bartley et al., 2006; Blenkinsop, 2008; Brisbin, 1986; Hutton et al., 1992; Lambert, 2013; Kisters et al., 1998).

This study takes place in an area known as Tantalite Valley near the rural settlement of Warmbad in southern Namibia. It forms part of an ongoing exploration and Mineral Resource delineation program for the company Orange River Pegmatite (Pty) Ltd (ORP), who is focused on developing a lithium-caesium-tantalum (LCT) type pegmatite-hosted tantalum deposit on its Exclusive Prospecting Licence (EPL) 5047, referred to as the "Swanson Tantalum Deposit" (Hattingh, 2020; Le Roux et al., 2020; Mullins and Petzer, 2021). The area currently being explored by ORP is historically known for numerous pegmatite-hosted tantalum occurrences (e.g., Doggart, 2019; Macey et al., 2015) and for hosting Namibia's only operating tantalum mine; the Namibian Tantalite Investment Mine (the NTI

mine), owned by Kazera Global Investments (<https://kazeraglobal.com/>; Kazera) and situated on Mining Licence No. 77 (ML 77; figure 1).

ORP has to date declared a JORC Maiden Mineral Resource of 1.2 Mt @ 412 ppm Ta₂O₅ + 76 ppm Nb₂O₅ + 0.29 wt. % Li₂O (with an applied cut-off grade of 236 ppm Ta₂O₅ and a minimum thickness of 1 m) for the Swanson Tantalum Deposit, currently placing it as an exceptionally *high grade* and *low tonnage* tantalum deposit relative to other known peer group tantalum deposits globally (Mullins and Petzer, 2021; <https://arcdiaminerals.global/>). ORP envisages that the project may be advanced to Feasibility Stage by Q3 of 2022 and that it is potentially amenable to small-scale mining operations by Q3 of 2023 (Hattingh, 2020; Le Roux et al., 2020). Ongoing exploration efforts are likely to expand the currently reported Mineral Resource (Mullins and Petzer, 2021; <https://arcdiaminerals.global/>) and feasibility stage work is also likely to convert a portion of this into the Mineral Reserve category (e.g., Hattingh, 2020; Le Roux et al., 2020). A Mining Licence Application for the deposit by ORP is also currently being processed by the Ministry of Mines and Energy of Namibia.

The Swanson Tantalum Deposit is comprised of a highly localised LCT-type pegmatite sill-and-dyke swarm occurring as part of the western portions of the regionally developed ~ 1 Ga Orange River Pegmatite Belt (ORPB). The individual mineralised pegmatites comprising the Swanson Tantalum Deposit intrude syn-tectonically into the crustal-scale Marshall Rocks – Pofadder Shear Zone (MRPSZ), and particularly into competent host rocks.

Up to the present day the Swanson Tantalum Deposit has remained largely undescribed in literature. This study therefore attempts to provide a baseline description of the deposit in the context of the ORPB and MRPSZ. It focuses on the litho-structural inventory and economic aspects of the deposit through field observations, litho-structural mapping, crosscutting and relative-timing relationships, and currently available exploration results. It incorporates all ORP's up-to-date exploration and geological data, such as mapping (1: 1000 scale), rock-chip- and channel sampling, diamond drilling, and metallurgical and mineralogical test work, as is relevant to ORP's Mining Licence Application Area (MLAA, i.e., the study area).

1.2 Location and physiography

The study area falls under the 1: 250 000 geological map series of Namibia sheet Warmbad-2818 and is bound within ORP's MLAA on farm Kinderzitt 132 (figure 1). It lies about 28 km's south-south-west of the rural settlement of Warmbad, 8 km's northwest of the NTI mine and 10 km's north of the Orange River and the international border of the Republic of South Africa.

The study area is located within a tributary of the southward flowing ephemeral Homs River drainage basin, a local sub-basin of the greater Orange River Valley as occurring in this region of southern Namibia. In the study area surrounds the Homs River drainage basin and its tributaries define a rugged and mountainous tract with deeply eroded valleys and inselbergs, making access challenging (figures 3A and 3B). The region encompassing the study area is arid and falls within an active erosional regime, therefore favouring limited regolith formation with good outcrop exposure being typical. The most prominent landmark in the area is the Signalberg peak, situated at 1069 meters above mean sea level within the topographically prominent mafic-ultramafic Tantalite Valley Complex (figures 1 and 2). Only a limited portion of the study area can be accessed by 4 x 4 off-road vehicle, while the remainder can only be accessed on foot.

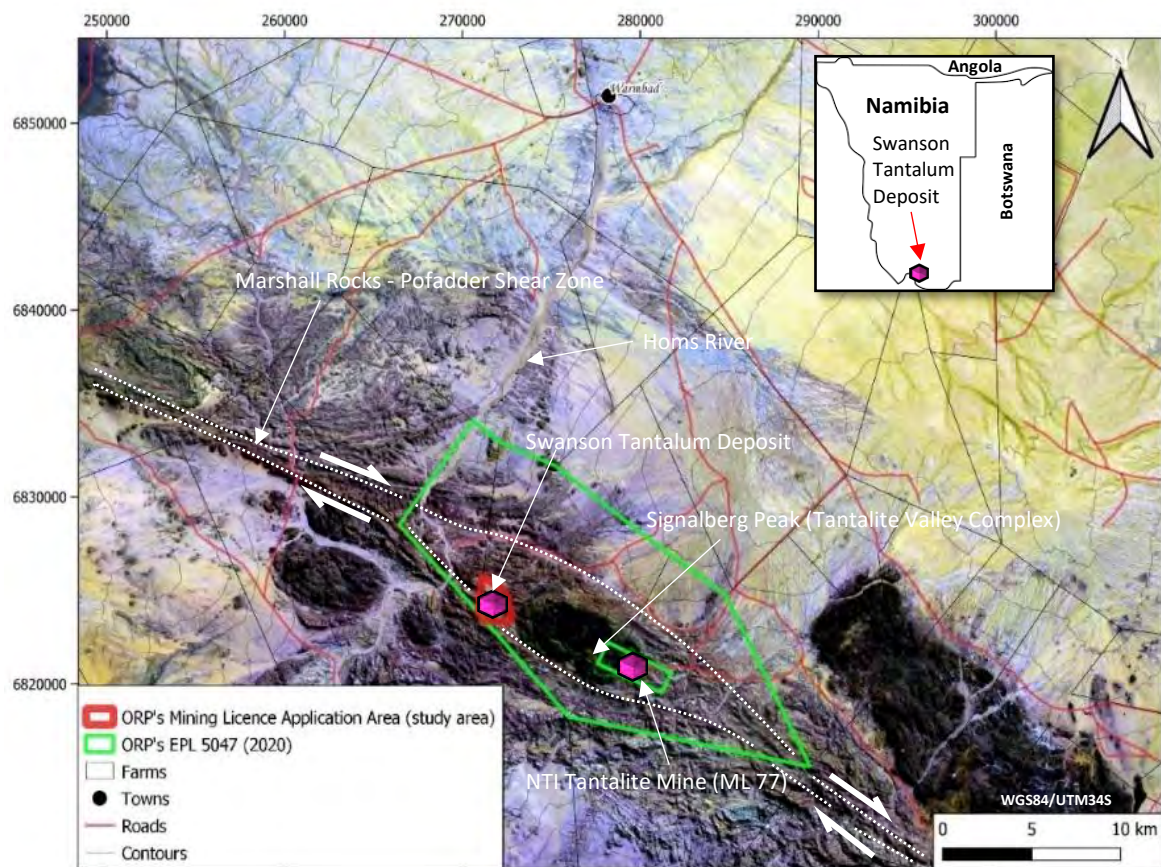


Figure 2: Geographic location of the Swanson Tantalum Deposit and the study area. The base map is a false colour Landsat 8 image covering the Marshall Rocks – Pofadder Shear Zone, Tantalite Valley Complex, and Kum Kum- and Sandfontein Klippe.

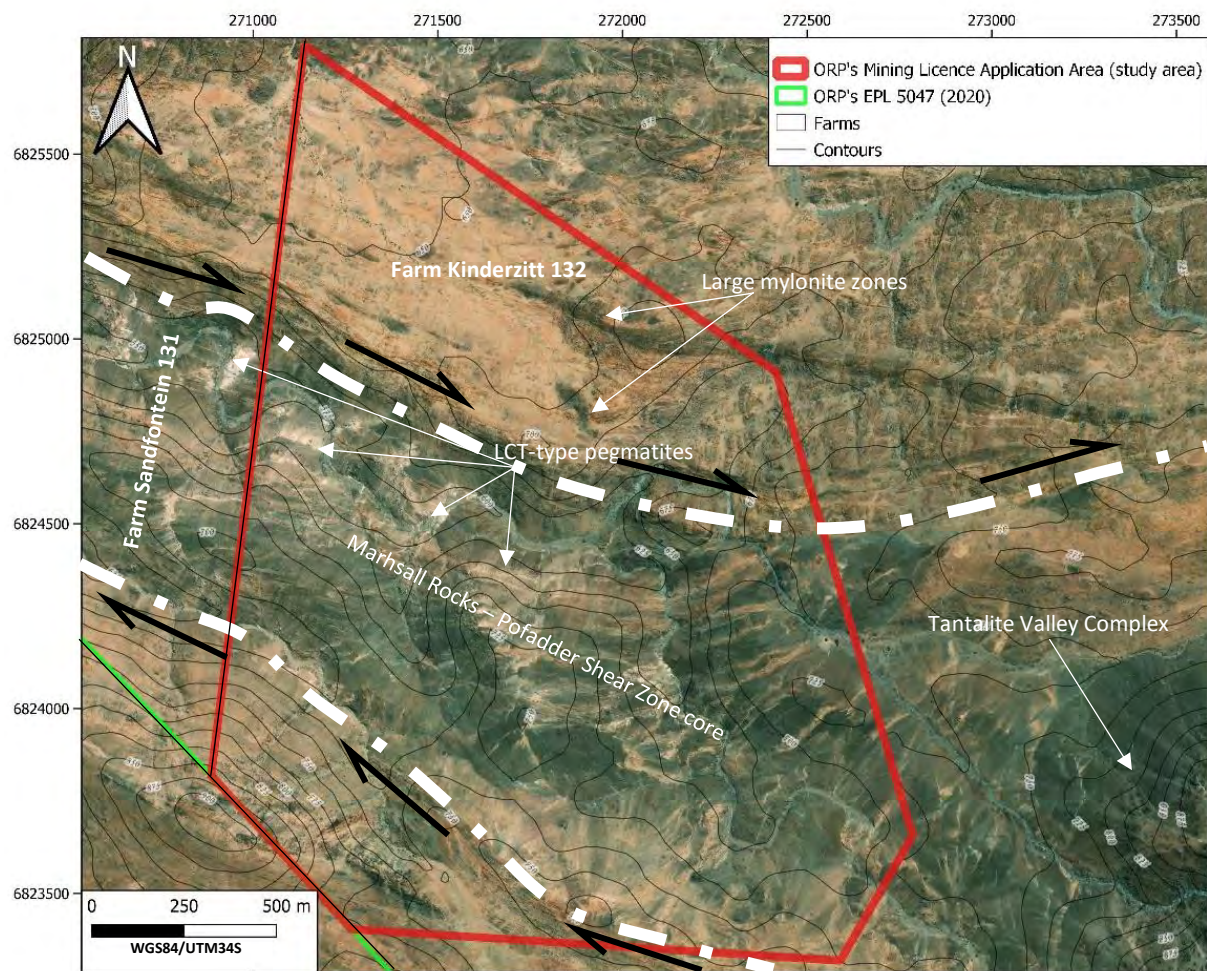


Figure 3: Aerial overview of ORP's MLAA (the study area).

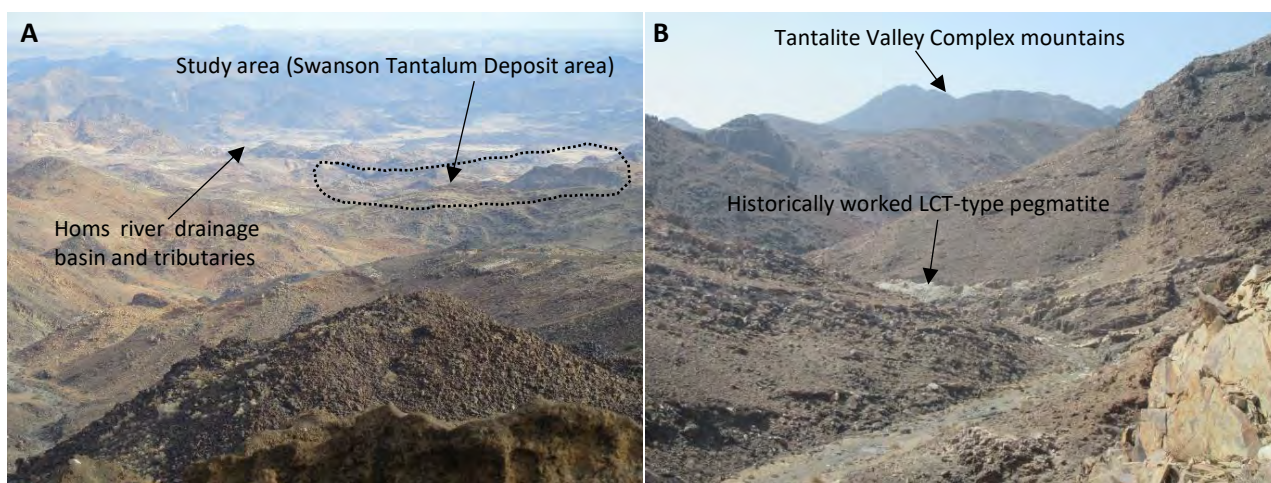


Figure 4: **A** - Scenic view of Orange River Pegmatite (Pty) Ltd.'s EPL 5047 as looking north-west towards the study area. The Homs River valley is visible in the immediate foreground. **B** - A south-east looking view of the tributary which crosscuts the immediate study area. Some pegmatites are visible within the central portions of the image. The high mountain in the background forms part of the Tantalite Valley Complex.

1.3 Objectives and outcomes

The objectives and outcomes of this study are to:

1. Document and describe the geology, mineralogy, structure, and economic aspects of the Swanson Tantalum Deposit.
2. Construct a relative timing framework regarding the intrusion of syn-tectonic melts within the study area and contribute to the understanding of the Marshall Rocks – Pofadder Shear Zone.
3. Produce a detailed geological map of the study area.

1.4 Previous work conducted within the Swanson Tantalum Deposit area

Studies which comprehensively summarize the general litho-structural inventory, tectono-metamorphic history, and overall geological framework of the immediate region in which the Swanson Tantalum Deposit area falls, i.e., of the locally occurring ~1.9 Ga (Paleoproterozoic) pre-Namaquan rocks of the Richtersveld Subprovince (or Richtersveld Magmatic Arc) and the ~ 1.2 – 0.9 Ga (Mesoproterozoic) Namaquan rocks and their associated tectonic assemblages, are: Angombe (2016), Beukes (1973), Cilliers (1989), Doggart (2019), Haughton et al. (1936), Indongo (2017); Kartun (1979), Lambert (2013), Macey et al. (2015, 2017), Moore (1975, 1981), Moore et al. (1979), Schreiber (2016), Toogood (1976) and Von Backström (1976). Angombe (2016), Doggart (2019), Indongo (2017), Lambert (2013) and Macey et al. (2015, 2017) represent collaborative works between the Namibian Geological Survey and the South African Council for Geoscience, who in 2016 published a comprehensive 1: 50 000 scale lithostratigraphic, tectonostratigraphic, and geochronological geospatial dataset of the Namibian Geological Series Sheet 2818 (Warmbad). These collaborative works represent the most comprehensive and up-to-date geological understanding of the region and are fundamental to the study area.

Studies which specifically investigate the timing, kinematics and general geological framework of the ~ 1.0 Ga late-tectonic tectonic-assemblages and the syn-tectonic magmatic rocks associated with them, here including the MRPSZ and pegmatites of the ORPB (this study), can be found in Angombe (2016), Cisneros-Lazaro et al. (2019), Doggart (2019), Diener et al. (2016), Indongo (2017), Lambert (2013) Macey et al. (2015, 2017), Maphumulo (2020), Melosh et al. (2014, 2015, 2016, 2018), Melosh (2015), Moore (1981), Toogood (1976) and Young (2017). Doggart (2019), Lambert (2013) and Maphumulo (2020) specifically focus on the geochronology and possible origins of syn- to late-tectonic pegmatites of the ORPB in relation to their host-structures and country rocks, and collectively define an association between prolonged ~ 1.0 Ga late-Namaqua deformation (i.e., late-stage crustal-scale shearing) and intrusion of pegmatite sill-and-dyke swarms.

Kartun (1979), Moore (1975, 1981), Moore et al. (1979) and Von Backström (1976) comprehensively summarize the geological characteristics of the mafic-ultramafic rocks of the ~ 1.2 Ga (Macey et al., 2015) Tantalite Valley Complex and the “hybrid mottled metagabbro” rocks (Kartun, 1979), the host rocks to the Swanson Tantalum Deposit.

Young et al. (1981) were the only explorationists to investigate the immediate Swanson Tantalum Deposit area prior to this study. Their work was mostly economically and reconnaissance orientated and does not provide a great deal of detail about the geology of the Swanson Tantalum Deposit area.

1.5 Definitions and origins of granitic pegmatites

Granitic pegmatites are texturally complex igneous rocks which are mostly composed of quartz (Qtz), sodic plagioclase (Ab), and alkali feldspar (Or), which modally sum to > 80 % at roughly subequal proportions (London, 2008). They are distinguished from other granitic igneous rocks by their diagnostic textural attributes; defined by (1) the extremely coarse and systematically variable size of its crystals, typically increasing in grain size from margins to centre, and (2) by an abundance of crystals with skeletal, graphic, or other strongly directional growth habits, and (3) by a prominent spatial zonation of mineral assemblages, including monomineralic zones (London, 2008, 2018). These complex textural attributes are the result of viscous granitic pegmatite melts being subject to appreciable liquidus undercooling (by $\sim 200^{\circ}\text{C} \pm 50^{\circ}\text{C}$) and the process of “constitutional zone refining” during their emplacement (e.g., London, 2008; figure 4).

During appreciable liquidus undercooling and constitutional zone refining of a rapidly cooling pegmatite intrusion a progressively flux- and incompatible element enriched (e.g., H_2O , B, P, F and Li, Rb, Cs, Be, Nb, Ta) boundary-melt layer develops and migrates away from the crystallization front, from the margins towards the centre. In the most fractionated granitic pegmatite melts, the sudden depletion or change in concentrations of flux- and incompatible elements of the bulk melt, as caused by the migration of the continually chemically evolving boundary-melt layer away from the crystallization front, results in sudden and abrupt changes in the types and forms of minerals species being crystallized (figure 4; London, 2018). Where this process has resulted in visible internal mineralogical and textural zonation, the pegmatites are referred to as “zoned” or “complex” pegmatites. Where this process has not resulted in visible mineralogical and textural zonation, the pegmatites are referred to as “un-zoned” or “simple” pegmatites (Dill, 2015; London, 2008, 2018).

Most granitic pegmatites contain garnet, tourmaline (B), beryl (Be), apatite (P), micas and fluorite (F) which are present in minor (< 5 %) to accessory (< 1 %) amounts. However, granitic pegmatites containing economically significant amounts of normally exotic minerals such as lithium aluminosilicates (Li), phosphates, beryl and/or Sn, Nb, Ta and rare earth element oxides, usually only

constitute a minute fraction (1 – 2 %) of all granitic pegmatites within a particular pegmatite field or district (defined as the most fractionated pegmatites which contain > 0.5 % Li₂O, or > 250 ppm Ta₂O₅, or > 300 ppm U; or > 0.3 % Sn, or > 0.3 % WO₃, or > 0.2 % Be, or > 0.1 % total rare earth oxides for example; Dill, 2015; London, 2008; Steiner, 2019). Such economically significant areas within pegmatite fields or districts may also express a broader and more generalized mineralogical and textural zonation, typically manifested as the sequential appearance and/or disappearance of such normally exotic minerals from area to area (London, 2008, 2018; Steiner, 2019).

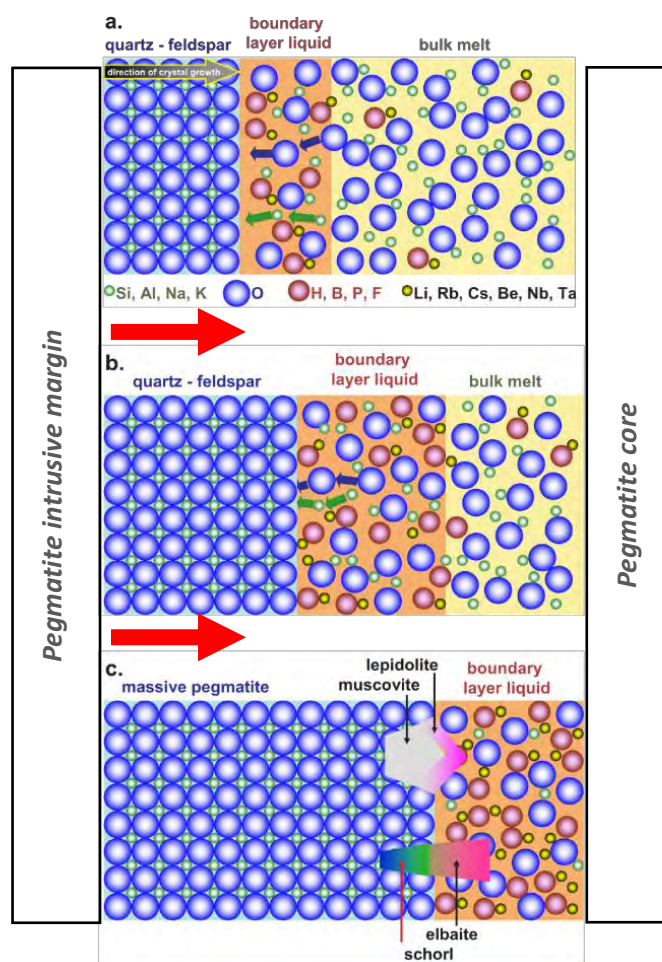


Figure 5: Schematic representation of the process of constitutional zone refining and the development of a flux- and incompatible element rich boundary-melt layer within a typical granitic pegmatite melt. Modified after London (2018). **(a)** More compatible elements exsolve from the bulk melt through the boundary-melt layer to attach to the surfaces of rock-forming minerals. **(b)** More incompatible elements become enriched in the boundary-melt layer because fluxes lower the solidus temperature and enhance the miscibility of all components. **(c)** When bulk-melt components are exhausted, crystallization ensues from the boundary-melt layer, leading to abrupt changes in the forms, habits and compositions of minerals that appear. The red arrow indicates the direction of crystal growth during the cooling of granitic pegmatite melts.

Available literature on the classification, geochemistry and petrogenesis of granitic pegmatites is vast and highly disputed, with numerous sub-classifications, required P-T-t, tectonic (geodynamic) settings and mineralisation controls having been outlined to date (e.g., Černý, P. and Ercit., 2005; Černý et al., 2012; Dill, 2015; London, 2008, 2018; Simmons et al., 2018; Simmons and Webber, 2008). However,

there is consensus that two distinct families of granitic pegmatites exist, namely Niobium-Yttrium-Fluorine (NYF)- and Lithium-Caesium-Tantalum (LCT) types. NYF-type pegmatites are diagnostically enriched in Nb-oxides, heavy rare earth elements (HREE's), and Y-rich fluorite and/or topaz, and are commonly associated with A-type and to a lesser extent I-type magmatism within anorogenic (rift-related) settings. LCT-type pegmatites are diagnostically enriched in lithium aluminosilicates, Ta-oxides, and pollucite (Cs), and are usually negligibly rare-earth-element (REE) enriched. They are commonly associated with S-type and to a lesser extent I-type magmatism and/or anatexis of deep-seated metasedimentary crust within Alpine or Variscan-type continent-continent collisional orogenic settings (e.g., Beltrando, 2015). In both cases, granitic pegmatites of primary economic interest, regardless of their chemical affiliation, depth, and temperature of emplacement, usually represent the more fractionated melts which occur on the furthest peripheries away from their source rocks. Collectively LCT- and NYF-type pegmatites are grouped together as “Rare-Element Pegmatites”, as they are often associated with economically significant quantities of rare-elements (e.g., Chappell, 1999; Černý et al., 1985; Dill, 2015; London, 2018; Steiner, 2019).

Both NYF- and LCT-type pegmatites, specifically those of primary economic interest, are typically emplaced as late syn-tectonic to early post-tectonic dykes-and-sills within structurally controlled dilatational anisotropies at relatively shallow (brittle-ductile to brittle) crustal levels (e.g., $\sim 2 - 3$ kpa, $\sim 350 - 500^{\circ}\text{C}$, geothermal gradients between $\sim 25 - 50^{\circ}\text{C}/\text{km}$; broadly greenschist to lower amphibolite facies; figure 5; Bradley et al., 2017; Brisbin, 1986; Černý, 1991; Dill, 2015; London, 2008; Steiner, 2019). The location and mode of granitic pegmatite melt migration and emplacement, and their final intrusive geometries and aspect ratios, ultimately arise from the prevailing strain and rheological states of the host rock into which they intrude (Brisbin, 1986; Dill, 2015).

Many economically significant pegmatite fields or districts globally are concurrently emplaced across multiple tectono-stratigraphic terranes over relatively long periods of time, and in many cases cannot be linked to a parental granite (e.g., Černý and Ercit; 2005; Dill, 2015; London, 2018; Novák et al., 2012). The local and regional distribution and characterization of economically significant pegmatites, with reference to their internal zonation, family type, host structures, and host rocks, has not been adequately addressed to date within present-day literature. At present there is not yet a universally accepted (holistic) model which explains the diversity and variety exhibited within pegmatites fields or districts, clusters or even within individual pegmatite bodies (e.g., Dill; 2015; Steiner, 2019; Simmons et al., 2015).

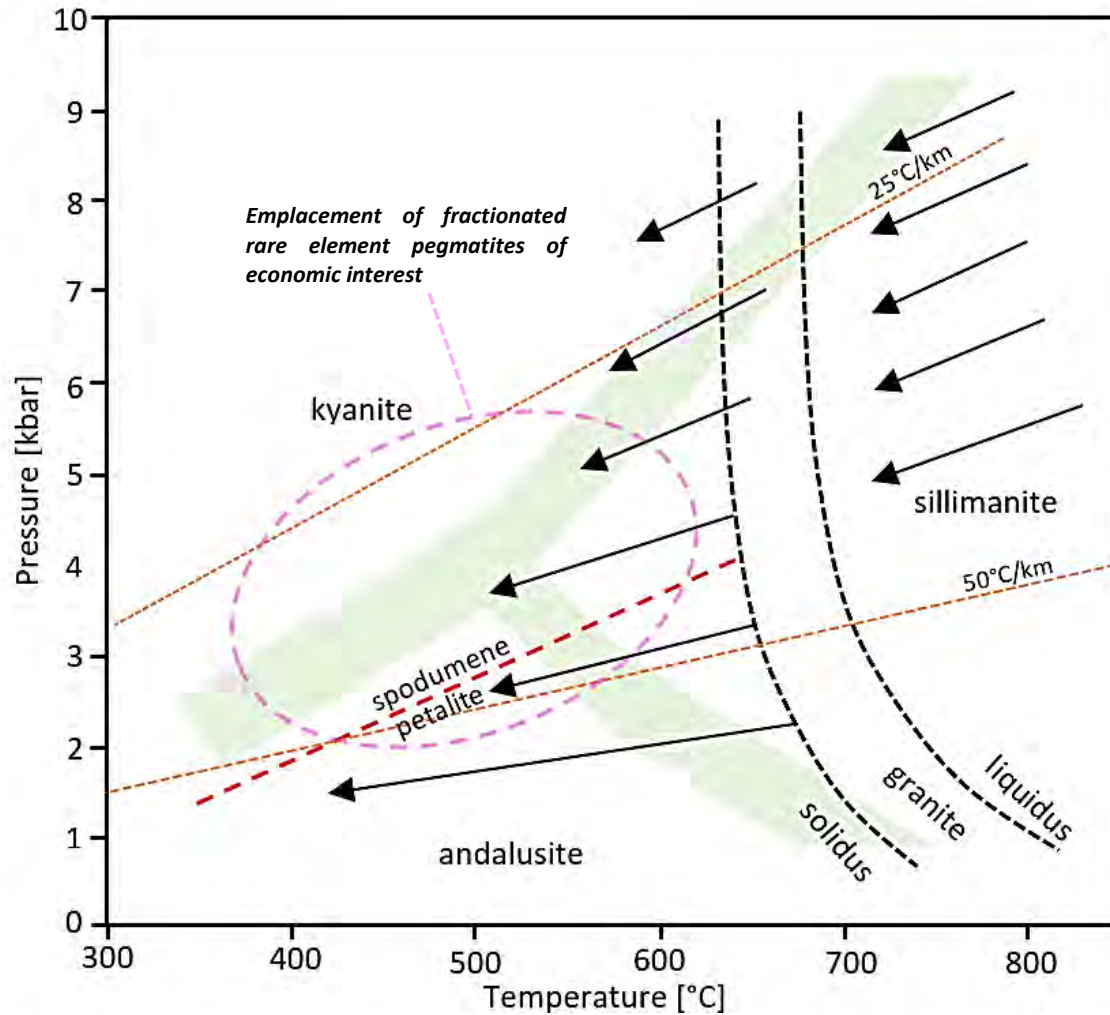


Figure 6: P-T diagram indicating a typical P-T window for the formation and emplacement of relatively highly fractionated rare-element pegmatites of economic interest to the explorationist. Modified after Černý (1991). The arrows indicate the regional trends of pegmatite fractionation, and the orange dotted lines regional geothermal gradients. The univariate lines between the spodumene-petalite (red dashed line) and aluminosilicate (light green area) stability fields are indicated as well as the granite solidus-liquidus P-T fields.

1.6 Syn-tectonic melts in shear zone systems

The migration and emplacement of melts through the crust, be it on a local or regional scale, has in many cases been temporally and/or spatially correlated with crustal-scale shear zone systems. They have been shown to exhibit a positive feedback relationship with strain-localization, stress gradients and fracture permeabilities which develop and change within the crust during progressive tectono-metamorphism (e.g., Angombe, 2017; Allibone et al., 1992; Anthonissen, 2010; Aranguren et al., 1997; Arthaud, 1993; Bartley et al., 2006; Blenkinsop, 2008; Bial et al., 2015a; Buick et al., 2008; Brisbin, 1986; Cartwright et al., 1999; Clemens et al., 2017; Doggart, 2019; Lambert, 2013; Macey et al., 2015; Hutton et al., 1992; Kisters et al., 1998). Syn-tectonic emplacement of melts within shear zone systems are evidenced by a continuum of preserved magmatic to overprinted tectonic structural fabrics that are compatible with prevailing shear zone system kinematics (e.g., Neves et al., 1996). Syn-tectonic

intrusions therefore serve as valuable geochronological markers for the tectono-metamorphic events with which they are associated (e.g., Doggart, 2019; Lambert, 2013; Macey et al., 2015, 2017).

Dilatational anisotropies associated with crustal-scale shear zone systems can facilitate channelized flow of melts, whereby such melts are “pumped” parallel to the maximum finite elongation direction of the prevailing strain regime at the time of and at the location of emplacement (Brisbin, 1986; Clemens et al., 2017; Lambert, 2013; Neves et al., 1996). Crustal-scale shear zone systems therefore act as fluid-flow pathways which may tap (and be further facilitated by) deep seated melt reservoirs, and channelize them into localized outcrop-scale structures, or into regional-scale composite structures (e.g., Fossen et al., 2017; Neves et al., 1996).

The mode of migration and emplacement of melts within a crustal-scale shear zone system is ultimately controlled by the prevailing strain regime of its host rocks, which is itself controlled by (1) pressure-temperature, (2) mineralogy, (3) internal rheological heterogeneities, competency (plasticity), and degree of isotropy, (4) degree of strain partitioning and strain localisation, (5) lithostatic and directed stresses, (5) effects of strain hardening and/or strain softening and (6) strain rate, and (7) (pH₂O) fluid pressure (figure 6; Brisbin, 1986; Clemens et al., 2017; Fossen et al., 2017; Kisters et al., 1998; e.g. Lambert, 2013).

In parts where the shear zone system is represented by a ductile-dominant strain regime and crystal-plastic (viscous) processes such as dislocation creep, mechanical twinning, and diffusion and/or dynamic recrystallization prevail, it is common for ascending melts to utilize syn-tectonic ductile fabrics such as S-C-C' shear bands, gneissic and/or mylonitic foliations (e.g., Brisbin, 1986; Lambert, 2013). In parts where the shear zone system is represented by a brittle-dominant strain regime and frictional-mechanical (cataclastic) processes such as grain fracture and grain size reduction, frictional sliding and grain rotation prevail, it is common for ascending melts to utilize syn-tectonic brittle fabrics such as tensile fractures (e.g., synthetic and/or antithetic Riedel shears, en-échelon arrays, conjugate fractures etc.), cleavage, schistosity and extensional fault jogs, and/or pre-existing fractures and sedimentary bedding (e.g., Brisbin, 1986; Lambert, 2013; Fossen et al., 2017).

The emplacement of pressurized melts within dilatational anisotropies further facilitates the nucleation and development of those dilatational anisotropies (i.e., further reduces the tensile strength of the host rock), thereby exhibiting a positive feedback association (Clemens et al., 2017; Neves et al., 1996). Melts intruded into dilatational anisotropies primarily in the ductile-dominant strain regime tend to form more isolated, irregular, and ellipsoidal bodies, whereas melts intruded into dilatational anisotropies in the brittle-dominant strain regime tend to form more strike- and dip-continuous planar bodies (Brisbin, 1986; Dill, 2015).

However, crustal-scale shear zone systems are markedly lithologically heterogenous, structurally complex and often have prolonged and complex tectono-metamorphic histories (Fossen et al., 2017). In addition, crustal scale shear zone systems, although being non-coaxial strain dominant, have been shown to commonly consist of complex three-dimensional combinations of coaxial and non-coaxial, and/or transpressional and transtentional strain domains, as well as exhibit concurrent overprinting of brittle and ductile fabrics (e.g., Fossen et al., 2017). Therefore, the local kinematics and strain-response of a shear zone system may have progressively changed and/or have been heterogeneously distributed/partitioned throughout different portions, and/or at different times, during its development. So also, the location and mode of migration and emplacement (response) of ascending melts within any part of that system.

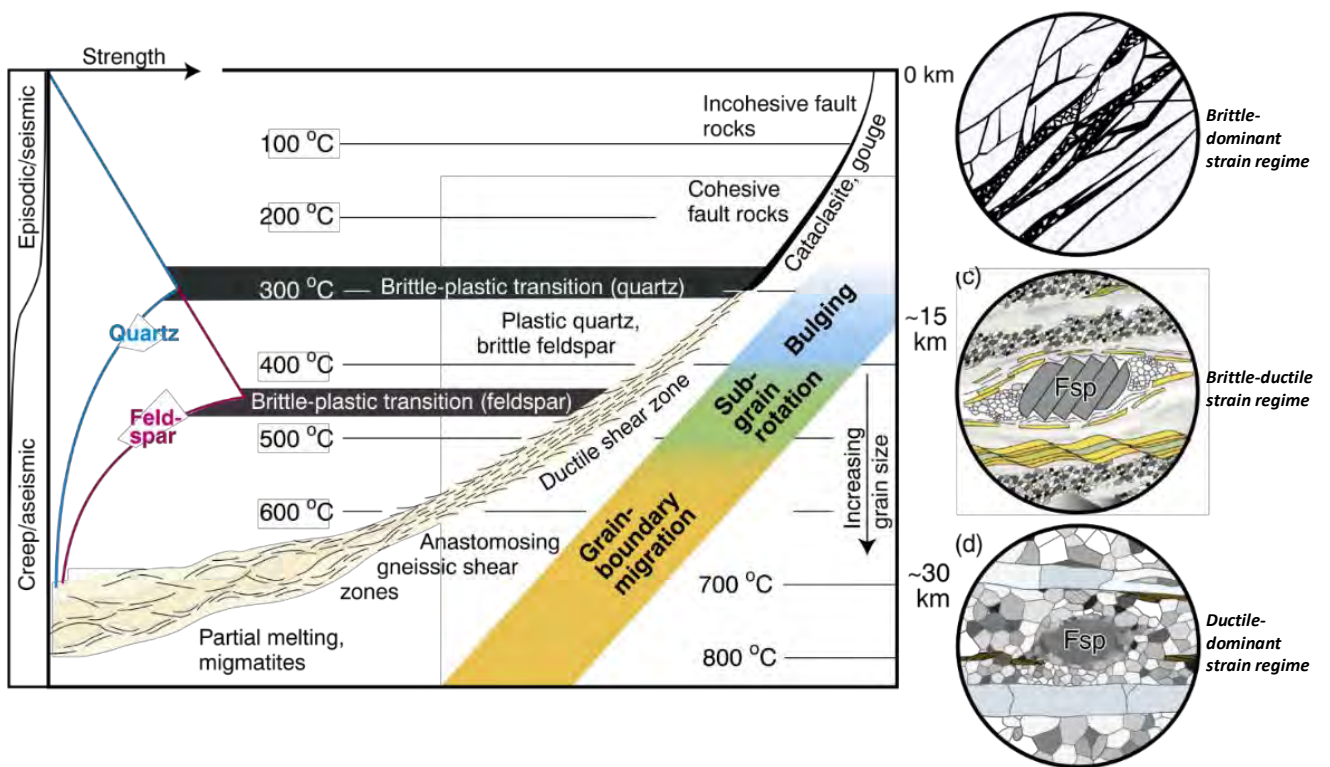


Figure 7: Simplified schematic indicating the vertical variation of the dominant strain-regime within a typical crustal-scale shear zone system. Modified after Fossen et al. (2017). Variations in the exact nature, position, depth, and timing of the dominant strain regime depend on local parameters such as pressure-temperature, mineralogy, internal rheological heterogeneities, competency (plasticity), and degree of isotropy, degree of strain partitioning and strain localisation, lithostatic and directed stresses, effects of strain hardening and/or strain softening and strain rate, and (pH_2O) fluid pressure.

2 Geological setting

2.1 The Namaqua Natal Metamorphic Province

The study area is situated within the western portions (i.e., the western Namaqua-sector) of Namaqua-Natal Metamorphic Province (NNMP; also referred to as the Namaqua Metamorphic Complex). The NNMP is a Mesoproterozoic, “Grenville-aged” (~1350 – 950 Ma) orogenic belt associated with the amalgamation of the supercontinent of Rodinia (Cornell et al., 2006; Li et al., 2008, Macey et al., 2015, 2017). It forms a ~400 km wide, and ~1800 km arcuate metamorphic belt comprising several juxtaposed tectono-stratigraphic terranes along the southern margins of the Kalahari Craton (Jacobs et al., 2008; Macey et al., 2015, 2017). The NNMP stretches from the east coast of South Africa (Kwazulu-Natal) to the south-west coast of southern Namibia (Lüderitz) (figure 7; Cornell et al., 2006).

2.2 The Namaqua-sector of the NNMP

The Namaqua-sector consists of Paleoproterozoic (~2020 – 1815 Ma) and Mesoproterozoic-Tonian (~1350 – 950 Ma) rocks that were variably deformed, metamorphosed, and juxtaposed during the polyphase Mesoproterozoic Namaqua Orogeny (Cornell et al., 2006; Li et al., 2008, Macey et al., 2015, 2017). The main lithostratigraphic components incorporated into the Namaqua Orogeny broadly comprise (1) reworked ~ 2.0 – 1.8 Ga pre-tectonic rocks, (2) highly metamorphosed and deformed ~ 1600 – 1200 Ma supracrustal and plutonic rocks formed during rifting, ocean spreading and subduction and (3) voluminous ~ 1350 – 950 Ma syn- to post-tectonic intrusives, mostly granitoids, with minor mafic and ultramafic components also present (Cornell et al., 2006; Macey et al., 2015, 2017).

Four main phases of deformation, namely D_1 – D_4 , have been identified in the Namaqua Sector (Joubert, 1986; Lambert, 2013; Macey et al., 2015, 2017). D_1 is represented by tight F_1 folding and an axial planar S_1 cleavage that developed during the greenschist facies Paleoproterozoic Orange River Orogeny at ~ 1.89 Ga. D_1 is only preserved in the western parts of the Paleoproterozoic Richtersveld Subprovince that remains largely unaffected by the younger Namaqua Orogeny (e.g., figure 8; Blignault, 1977; Macey et al., 2015, 2017).

D_2 comprises the main phase of the polyphase medium- to high-grade Namaqua Orogeny (~ 1200 – 1100 Ma; e.g., Eglington, 2006; Macey et al., 2017; 2018) and is characterised by low-angle top-to-the-southwest nappe tectonics, large-scale thrusting (e.g., the Tafelkop Shear, Onseepkans Thrust, Lower-Fish River-Oseepkans Thrust Zone, Groothoek Thrust, Keimasmund Klippe, Kum-Kum Klippe and Sandfontein Klippe) and the juxtaposition of various tectonostratigraphic terranes (Cornell et al., 2006; Macey et al., 2015, 2017, 2018). These tectono-stratigraphic terranes are from northeast to

southwest, the Kaaiken-, Areachap- and Kakamas terranes, Lower Fish River - Onseepkans Thrust Zone, and the Richtersveld- and Bushmanland Subprovinces (figure 7; Cornell et al., 2006; Macey et al., 2015, 2017). The Lower Fish River-Onseepkans Thrust Zone (LFROTZ) is a major low-angle D_2 structure that separates the high-grade Kakamas Domain from the medium-grade eastern Richtersveld Subprovince (figure 8; Macey et al., 2015, 2017). A sub-horizontal penetrative ductile S_2 gneissic foliation, large scale E-W trending isoclinal F_2 folding, ENE-plunging L_2 mineral stretching lineations, and considerable volumes of ~ 1200 Ma syn-tectonic and granitic intrusives and to a lesser extent mafic-ultramafic intrusives (e.g., the Orange Falls-, Eendoorn- and Kum Kum Suites; figure 8) characterise D_2 (Macey et al., 2015, 2017; Toogood, 1976).

D_3 comprises the reorientation of S_2 , F_2 and L_2 into regionally developed mega-scale (2 – 20 km) open and shallowly plunging F_3 folds between $\sim 1100 - 1030$ Ma (Macey et al., 2015, 2017). S_3 is very poorly developed due to the openness of the F_3 folds. D_3 has been associated with peak metamorphic conditions within the Bushmanland Subprovince (Cornell et al., 2016; Macey et al., 2015, 2017).

D_4 is represented by NW-SE trending discrete crustal scale transcurrent, steeply dipping dextral ductile to brittle-ductile shear zones, locally the Marshall Rocks – Pofadder Shear Zone (MRPSZ), Eureka Shear Zone (ESZ) and Sperlingsputs Shear Zone (SPSZ) (Angombe 2016; Indongo, 2017; Lambert, 2013; Macey et al., 2015, 2017; Melosh et al., 2018; Moore, 1981; Toogood, 1976). It has been associated with lateral-escape tectonics within the Namaqua-orogen between $\sim 1040 - 950$ Ma (e.g., Thomas and Jacobs, 1994). Emplacement of voluminous pegmatites of the Orange River Pegmatite Belt (ORPB) and S-type leucogranites of Warmbad Granite Suite occurred contemporaneously with D_4 shearing (figure 8; Beukes, 1973; Doggart, 2019; Lambert, 2013; Macey et al., 2015; 2017). D_4 fabrics will be discussed in detail in Chapter 2.5.2. The pegmatite-hosted Swanson Tantalum Deposit is situated in the MRPSZ, where it crosscuts the LFROTZ melange (e.g., Macey et al., 2015).

There are also post-Namaqua D_5 brittle structures which crosscut older fabrics at high angles. These structures consist of fault-breccia, fault-gouge, joints, and veins, and are not associated with any obvious magmatism, metamorphism or pervasive mineral stretching lineations or foliations (e.g., Angombe, 2016; Indongo, 2017; Macey et al., 2015, 2017).

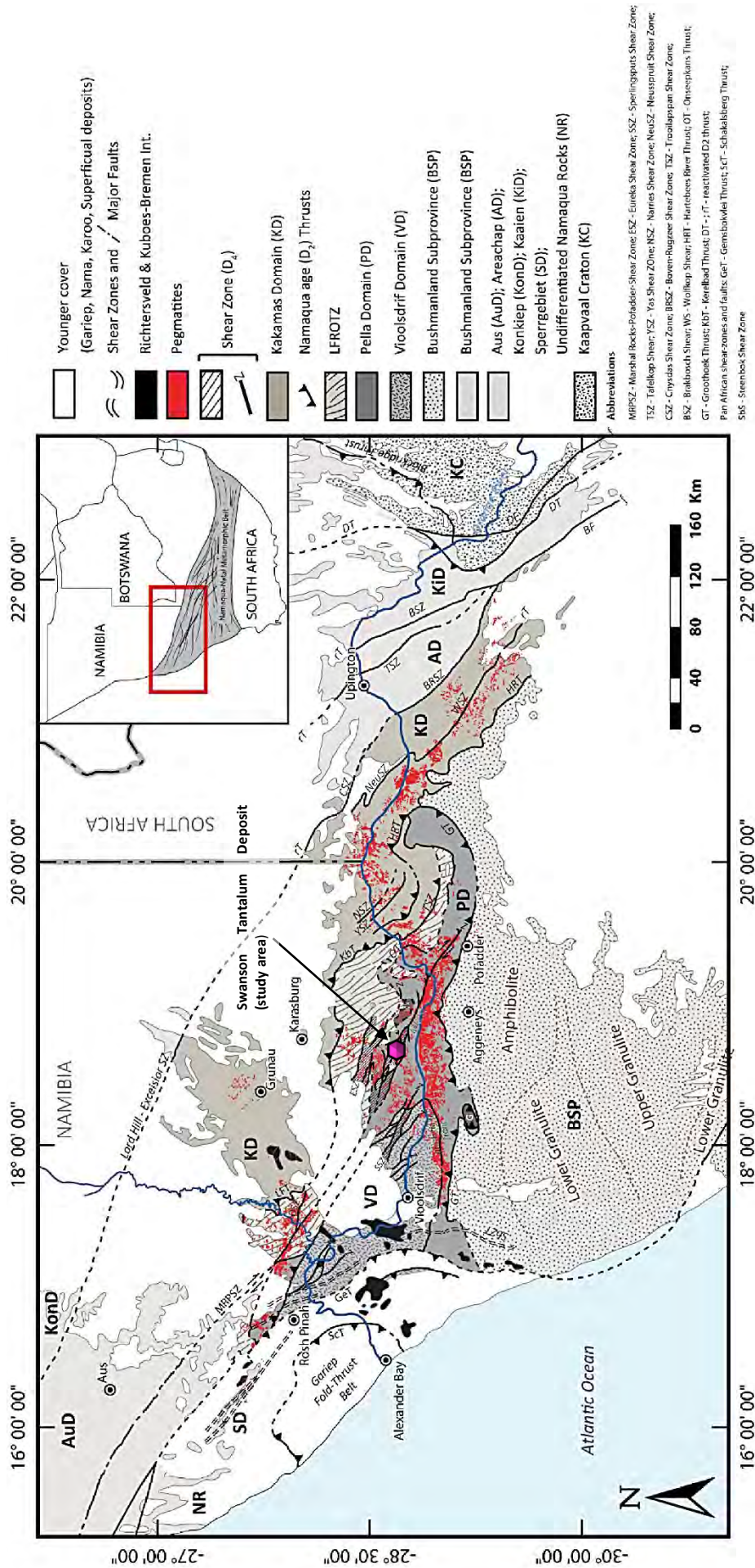


Figure 8: A tectono-stratigraphic map of the Namaqua-sector of the NNMP and its various terranes, with the regional distribution of late-Namaqua (~950 – 1040 Ma) pegmatites of the Orange River Pegmatite Belt indicated. Modified from Daggart (2019) after Macey et al (2015, 2017). The Swanson Tantalum Deposit's (the study area) position relative to the Richtersveld Subprovince, Orange River Pegmatite Belt, Lower Fish River-Onseepkans Thrust Zone, and late-Namaqua crustal scale shear zones is also indicated. Note that the ORPB seems to follow the extend and trend of regionally developed D₂ sole thrusts and klippen.

2.3 The Paleoproterozoic Richtersveld Subprovince

The Richtersveld Subprovince, also referred to as the “Richtersveld Magmatic Arc” (RMA) by Macey et al. (2017), is mostly comprised of variably reworked pre-tectonic Paleoproterozoic (~ 1880 – 2000 Ma) continental crust (with a possible Archean heritage) incorporated into the Namaquan-orogeny (Blignault, 1997; Cornell et al., 2006; Macey et al., 2015). It consists primarily of variably metamorphosed and poly-deformed volcano-sedimentary successions of the (~ 2000 Ma) Orange River Group and associated intrusive plutonic rocks of the (~ 1880 Ma) Vioolsdrift Suite, both of which indicate a distinctively calc-alkaline dominant character and to have likely formed during multiple cycles of plutonism, volcanism and sedimentation associated with an evolving volcanic island arc setting (Macey et al., 2015, 2017). It is further sub-divided into the western lower metamorphic grade (not exceeding greenschist facies metamorphic conditions) Vioolsdrift Domain and the eastern medium-metamorphic grade (peak amphibolite facies metamorphic conditions, ~ 600°C, 5 – 6 kbar) Pella Domain, which are partially juxtaposed through various shear zones of the late-Namaquan Marshall Rocks – Pofadder Shear Zone system (figures 7 and 8; Macey et al., 2015, 2017). The rocks of the Orange River Group and Vioolsdrift Suite can be correlated across both the Vioolsdrift- and Pella Domains, although they are represented by different metamorphic- and structural equivalents (Macey et al., 2015, 2017).

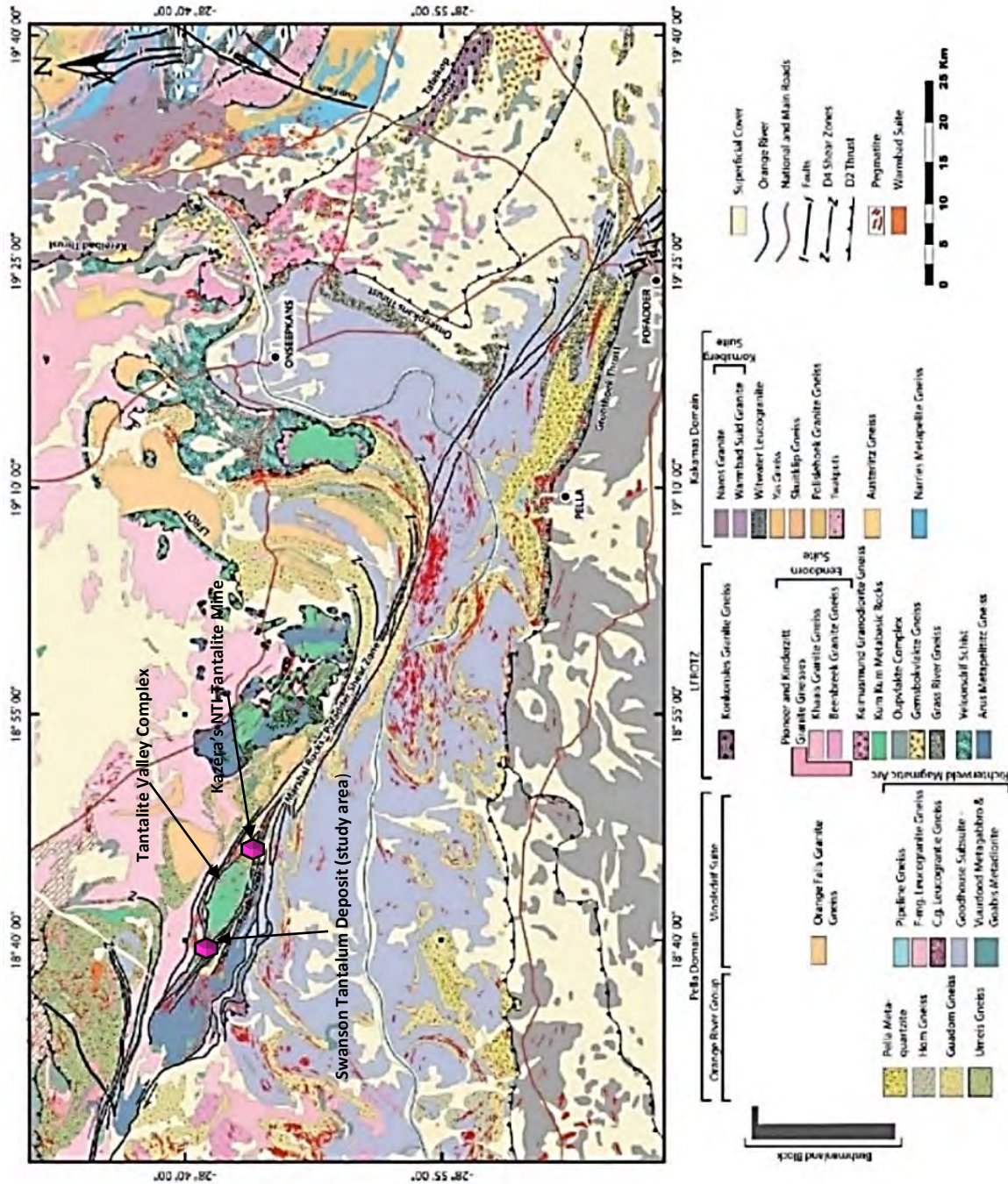


Figure 8: Simplified geological map of the Pella Domain, illustrating major structures, tectonic boundaries and pegmatite distribution. Modified after Daggart (2019) and Macey et al. (2015).

2.4 Lower Fish River - Onseepkans Thrust Zone

2.4.1 Introduction

The Lower Fish River – Onseepkans Thrust Zone (LFROTZ) is a major D₂ structure which comprises a ~ 10 – 25 km wide, shallow NE-dipping to sub-horizontal, complex imbricate zone that separates amphibolite-facies Paleoproterozoic gneisses of the Pella Domain (footwall) from granulitic rocks of the mainly Mesoproterozoic Kakamas Domain (hanging-wall) (figures 7 and 8; Macey et al., 2015; Smith et al., 2016). The hanging-wall is marked by the Lower Fish-Kerelbad-Tafelkop Thrust, and the footwall by the Onseepkans Thrust (e.g., Macey et al., 2015; Smith et al., 2016). The LFROTZ consists of interleaved sheets of highly sheared gneisses derived from both the Kakamas and Pella Domains, as well as slices of exotic rocks not native to either (Macey et al., 2015; Smith et al., 2016). Polyphase deformation within the LFROTZ has been constrained to ~ 1200 – 1100 Ma, with the main deformation phases occurring ~1215 – 1200 Ma (D_{2a}), ~1200 ± 5 Ma (D_{2b}) and ~1100 Ma (D_{2c}) (Macey et al., 2015; Smith et al., 2016).

The LFROTZ is locally folded by the regionally developed mega-scale F₃ folds and is reworked by D₄ transcurrent dextral shear zones of the MRPSZ, synchronous to the intrusion of pegmatites and leucogranites of the ORPB and Warmbad Granite Suite (Macey et al., 2015, 2017).

2.4.2 Arus Gneiss

The Arus Gneiss is regionally described as dominantly restitic/migmatitic grt-crd-bt-fsp pelite granulite, psammite gneiss, and leucogranite with minor mafic granulite, amphibolite, and calc-silicates of uncertain origin (Beukes, 1973; Macey et al., 2015). It represents a rock unit incorporated into D₂ LFROTZ, and which was locally reworked into the D₄ MRPSZ. It is the oldest and highest-grade metamorphic rocks in the area and has been suggested to have been deposited at ~ 1.8 Ga, with migmatitisation likely occurring contemporaneously with the main phases of D₂ (Macey et al., 2015; Minnaar, 2012).

2.4.3 Tantalite Valley Complex & hybrid mottled metagabbro

The ca. 9 x 3 km Tantalite Valley Complex (TVC; figures 1, 8, 9 and 10) consists of variably altered metagabbro, metatroctolite and minor ultramafic rocks of the ~ 1.2 Ga Kum Kum Suite (Beukes, 1973; Macey et al., 2015, 2017; Moore, 1975, 1981; Moore et al., 1979, Kartun, 1979, Von Backström, 1976). It has been dated to ~ 1212 Ma by Macey et al. (2015) and is thought to have possibly intruded into various medium-grade gneisses of the Orange River Group during early-D₂, and to later be enveloped by S₄ mylonites within the core of the MRPSZ (Beukes, 1973; Kartun, 1979, Moore, 1975, 1981; Toogood, 1976; Von Backström, 1976). The mafic-ultramafic rocks of the TVC have been shown to be of high alumina olivine tholeiite compositions with cumulate textures predominating. These

rocks show severe depletion in lithophile elements and enrichment in nickel, copper, and chrome relative to average tholeiites and high alumina tholeiites (Beukes, 1973; Kartun, 1979; Moore, 1981). The TVC has been subject to exploration for Ni-Cu-PGE mineralisation in the past and has been compared to Alaskan-type layered mafic-ultramafic complexes (Beukes, 1973; Kartun, 1979; Moore, 1981; Von Backström, 1976).

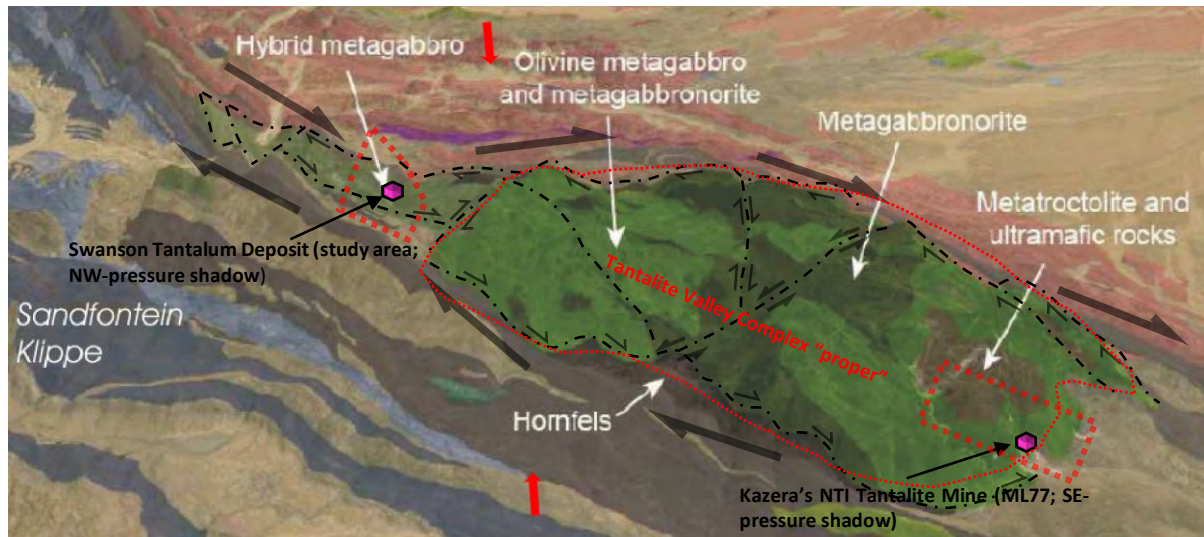


Figure 9: Schematic representation of the various rock types and structures comprising the TVC and its country rocks. Modified after Macey et al (2015). Roughly estimated principal stress directions are indicated by red arrows.

Preserved contact-metamorphic hornfelsic rocks also remain in places along the TVC's contact margins (Kartun, 1979; Macey et al., 2015, 2017; Moore et al., 1979, Moore 1979, 1981). The main body's interior margins are strongly foliated with retrograde chlorite, talc, amphibole, and serpentinite being commonly developed (figure 9; Kartun, 1979; Macey et al., 2015; Von Backström, 1976).

The gneissic and mylonitic rocks surrounding the TVC appear to "flow" along its margins and converge at both its north-western and south-eastern extremities (e.g., Toogood, 1976). The TVC has a flattened, stretched and partially boudinaged appearance parallel to the trend of the MRPSZ core (figure 9). It resembles a 9 x 3 km shear zone bound competent mega-porphyroclast, with melt accumulation and associated economically significant pegmatite-hosted mineralisation (i.e., the Swanson Tantalum Deposit and the NTI Tantalite Mine) preferentially occurring in its north-western and south-eastern pressure shadows (e.g., Kartun, 1979; Macey et al., 2015; Moore, 1975; Toogood, 1976; Von Backström, 1976; figures 9 and 10).

Von Backström's (1976) geological map of the TVC, although not being in exact agreement with the map of Macey et al (2015) (figure 9), is presented in figure 10 for additional reference.

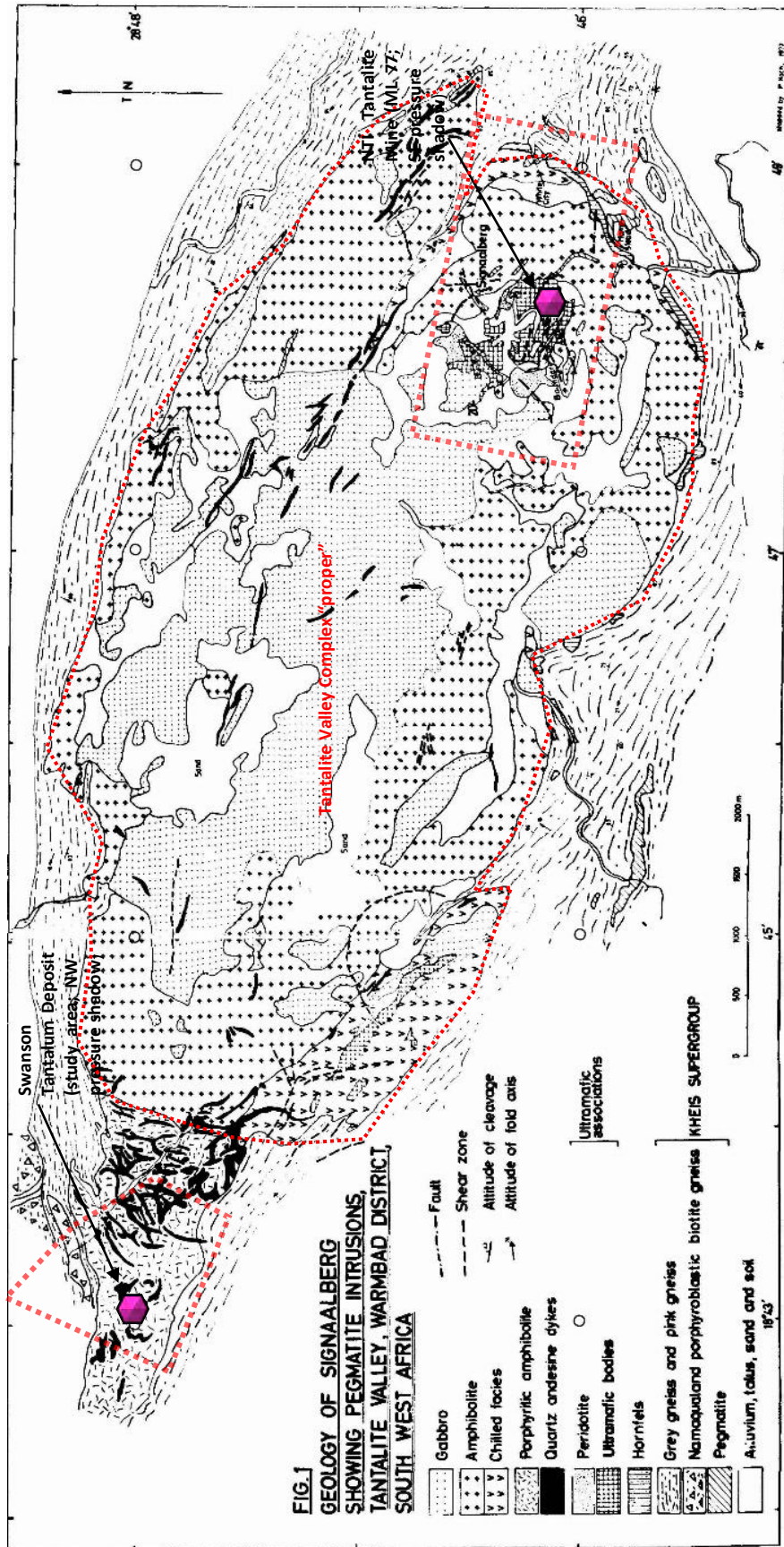


Figure 10: Geological map of the TVC and its immediate country rocks. Modified after Von Backström (1976). Note that this is the only known map indicating the geographical distribution of the “quartz-andesine intrusives” of Von Backström (1976) and Kartun (1979). This map does not indicate that pegmatites of the ORPB are occurring within the study area.

2.4.3.1 *The hybrid mottled metagabbro*

This rock unit has been informally termed the “*hybrid mottled metagabbro*” (HMG) by Kartun (1979) and also Macey et al. (2015), and as “porphyritic amphibolite” by Von Backström (1976), due to the exotic and complex magma mingling textures and diverse rock types associated with it (e.g., Macey et al., 2015; Kartun, 1979; Von Backström, 1976). In this study this term will reluctantly be adopted and be used all-inclusively to refer to these rocks. This term does not serve to differentiate between sub-types of associated rocks as based on composition or texture. It would have been preferable that previous authors did not include “gabbro” within the term, as the composition, petrography and textures of these rocks remain very poorly studied and there is certainly a great deal of uncertainty with regards to its origin and relationship with the TVC proper.

The HMG extends from the northwest portions of the TVC and represents the bulk of the study area’s host rocks (e.g., figures 2, 9 and 10). Traditionally it has been grouped under the ~ 1.2 Ga Kum Kum Suite (e.g., Macey et al., 2015, 2017). It is typically described as a localised extension of TVC which was subjected to magma mixing with Eendoorn Suite (Kartun, 1979; Macey et al., 2015).

The HMG and its relationship with the MRPSZ will be investigated in more detail in this study. Subsequently, the main body of the TVC, which excludes the HMG, will in this study be referred to as the Tantalite Valley Complex proper, to instil a clear separation between these rock units (e.g., figures 9 and 10). The HMG is discussed in more detail in Chapters 4.3.3 and 6.4.

2.4.4 Eendoorn Suite

The Eendoorn Suite comprises variably sheared megacrystic and porphyroclastic granodioritic- to granitic gneisses which intruded syn-D₂ as sub-horizontal sheets along the LFROTZ (e.g., Macey et al., 2015; Smith et al., 2016). The Eendoorn Suite rocks are easily identified by diagnostic tabular to ovoid, usually twinned sunhedral to euhedral K-feldspar megacrysts set in a coarse grained, commonly garniferous quartz, feldspar, and biotite matrix and have been constrained in age between ~ 1210 – 1190 Ma (Macey et al., 2015, 2017). The Eendoorn Suite granitoids show regional variations distinguished by size and shape of megacrysts, garnet content, strain, geographical distribution, and tectono-lithological association (Macey et al., 2015). It comprises six identified varieties, namely the (1) Kinderzitt Granite (porphyroclastic alkali feldspar granite to granodioritic gneiss), (2) Pioneer Granite (porphyroclastic granodiorite gneiss), (3) Khaais Granite Gneiss, (4) Beenbreek Granite, (5) Twakputs Gneiss and (6) Bokkiesbank Granite (Macey et al., 2015, 2017). Elsewhere in the region these rocks have been shown to be locally charnockitic (Macey et al., 2015). The Kinderzitt Granite variety occurs within the study area.

2.5 The Marshall Rocks - Pofadder Shear Zone and associated granite and pegmatite intrusions

2.5.1 Introduction

The ca. 500 km D₄ MRPSZ, in which the study area is immediately situated, forms one of the largest shear zones in Africa. It comprises a ~ 4 – 7 km wide NW-SE trending and steeply NE-dipping (50 - 80°) splay-system of numerous localized, pervasive and/or penetrative anastomosing high-strain zones of proto- to ultramylonites, as well as discrete retrogressed cataclasites (S₄). Regionally, the D₄ MRPSZ-system is expressed by ~ 30 km right lateral ductile drag of older D₂/D₃ (gneissic) tectono-metamorphic fabrics into its core zone (Cisneros-Lazaro et al., 2019; Kartun, 1979; Lambert, 2013; Macey et al., 2015, 2017; Toogood, 1976), as well as by km-scale sigmoidal mylonite-bound (rigid-body) lithons compatible with MRPSZ-system kinematics (e.g., Cisneros-Lazaro et al., 2019; Indongo, 2017; e.g., the Tantalite Valley Complex; e.g., figures 1, 2, 7, 8, 9 and 10). Locally it crosscuts the LFROTZ, while exhibiting variable dip-slip and strike-slip kinematics throughout (e.g., Angombe, 2016; Indongo, 2017; Macey et al., 2015; Toogood, 1976). It is currently inferred to have been active between ~ 1040 – 950 Ma as based primarily on geochronology of syn-tectonic pegmatites of the ORPB (e.g., Doggart, 2019; Lambert, 2013; Maphumulo, 2020; Macey et al., 2015, 2017; Melcher et al., 2008).

Bulk shearing within the MRPSZ is thought to have occurred under a relatively fluid under-saturated (~ 2 - 3 mol % H₂O, i.e., low fluid-to-rock ratios) mid-crustal ductile to brittle-ductile strain-regime (i.e., viscous-frictional flow defined by the viscous flow of quartz and mica surrounding more brittle feldspar porphyroclasts in a predominantly S-S-C' mylonitic fabric; e.g., Cisneros-Lazaro et al., 2019; Diener et al., 2016; figure 6) and to have been sustained for a period of at least ~ 37 Ma (if not longer) at pressure-temperature conditions ranging between ~ 550 - 450 °C and ~ 4 - 5 Kbar (~ 10 – 18 km depth; Cisneros-Lazaro et al., 2019; Diener et al., 2016; Doggart, 2019; Lambert, 2013; Toogood, 1976).

2.5.2 Tectonic rocks and fabrics of the MRPSZ

Regionally, and locally, D₄-fabrics are expressed mainly through ductile drag and incorporation of earlier tectono-metamorphic fabrics into NW-SE trending and steeply to moderately NE dipping, non-coaxial dominant, right lateral, strike-slip, high-strain zones (e.g., Angombe, 2016; Indongo, 2017; Lambert, 2013; Macey et al., 2015; Toogood, 1976). S₄ is represented by the discrete to pervasive, anastomosing, and penetrative mylonitic foliations associated with these high strain zones. Intrafolial asymmetric shear folding of S₄, as well of folding of rheologically competent lithologies incorporated into-, and adjacent to D₄ high strain zones, represents F₄. Mineral stretching lineations on S₄ represent

L_4 and vary from sub-horizontal to sub-vertical, with the local plunges of intrafolial F_4 fold hinges commonly being sub-parallel to the plunges of L_4 , and the dip and strike of F_4 axial planes commonly being sub-parallel to the dip and strike of S_4 (figure 11; e.g., Angombe, 2016; Cisneros-Lazaro et al., 2019; Lambert, 2013; Macey et al., 2015; Indongo, 2017; Toogood, 1976). Syn- to post D_4 S-type pegmatites and leucogranites of the ORPB and Warmbad Granite Suite have locally, to varying degrees, utilized D_4 related structural anisotropies (Angombe, 2016; Doggart, 2019; Indongo, 2017; Lambert, 2013; Macey et al, 2015, 2017).

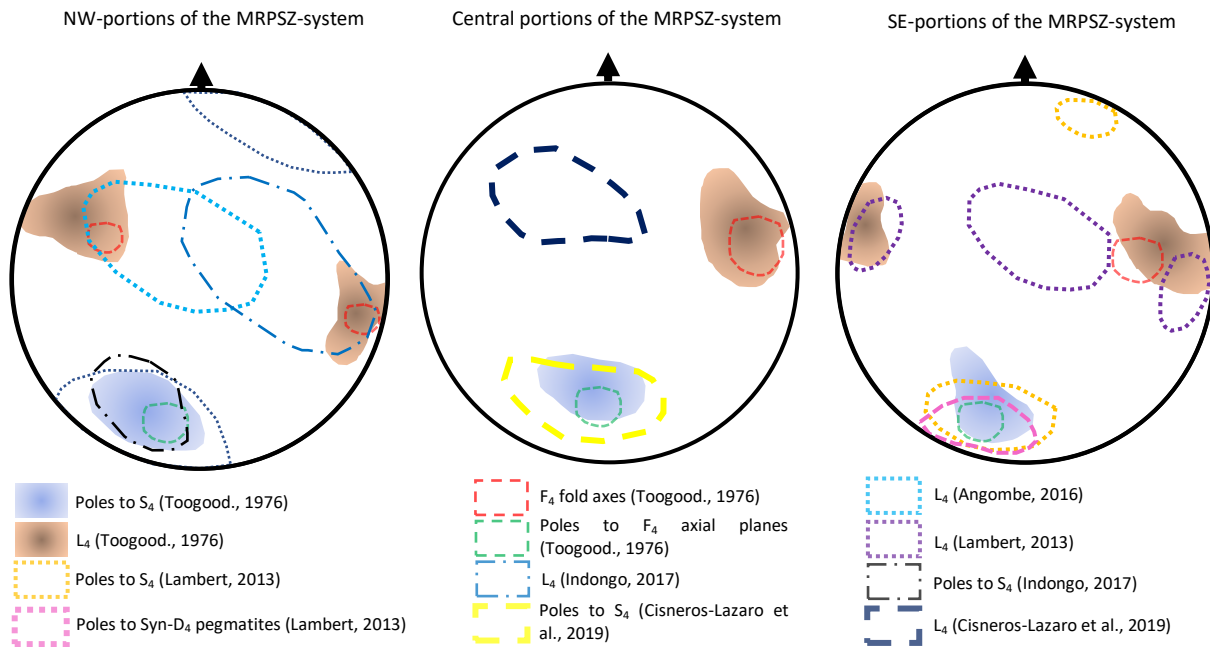


Figure 11: Schematic lower hemisphere equal area stereographic representation of orientation data groupings collected by Angombe (2016), Cisneros-Lazaro et al. (2019), Lambert (2013), Indongo (2017) and Toogood (1976) across various high-strain portions of the locally occurring MRPSZ-system (which includes the ESZ and SPSZ). L_4 has large degrees of variation on S_4 , and F_4 fold hinge plunges are typically sub-parallel to L_4 , and F_4 axial planes typically dip and strike sub-parallel to S_4 . Retrogressed fabrics cannot be definitively grouped between authors and are therefore not separated here into unique groupings. Therefore local-scale kinematic indicators within high-strain zones vary greatly from place to place within the MRPSZ-system, as depending on various factors controlling the local partitioning of strain.

The geometry and kinematics of high strain zones within the MRPSZ-system have been shown to vary depending on how strain and fluid-flow were locally partitioned (figure 11; e.g., Angombe, 2016; Indongo, 2017; Lambert, 2013; Toogood, 1976; this study). For example, Angombe (2016), Indongo (2017), Lambert (2013) and Toogood (1976) collectively noted that in high strain mylonitic zones L_4 (and so also F_4) may vary in attitude from dip-parallel to strike-parallel on S_4 , while S_4 itself may strike from NW to NE, and dip SW or NE, depending on the prevailing strain intensity, position relative to the core of the shear zone, state of local retrogression, and proximity to rigid bodies (figure 11). Lambert (2013) also illustrated that many “older” syn- D_4 pegmatites and leucogranites, and so associated D_4 -fabrics, locally exhibit asymmetry relative to shearing, but elsewhere, and still in close proximity, may again be pervasively cut by and/or transposed into “younger” D_4 -fabrics, and then yet again be accompanied by successive emplacement of syn- D_4 pegmatites and leucogranites. Angombe

(2016), Cisneros-Lazaro et al. (2019), Indongo (2017) and Toogood (1976) also noted the local occurrence of sinistral mylonitic fabrics within such high strain zones.

D₄ fabrics within high strain zones of the MRPSZ-system were continuously reworked and variably transposed, possibly at relatively constant and elevated P-T conditions (e.g., Cisneros-Lazaro et al., 2019; Diener et al., 2016), with many factors influencing their kinematics. If so, the regional and local separation between younger and older D₄ fabrics can be problematic and complex (as in Lambert, 2013; Macey et al., 2015, 2017; illustrated in figure 11).

Numerous examples of syn-tectonic retrogressed (i.e., viz. chlorite-epidote-muscovite) cataclastic S₄ fabrics have been documented within the MRPSZ-system (e.g., Angombe, 2016; Indongo, Kartun, 1979; 2017; Lambert, 2013; Macey et al., 2015, 2017; Melosh 2015; Melosh et al., 2014, 2015, 2016, 2018; Toogood, 1976). These fabrics have usually been associated with progressive syn-tectonic exhumation of the MRPSZ-system and its country rocks from amphibolite towards greenschist facies P-T fields (e.g., Angombe, 2016; Lambert, 2013; Indongo, 2017, Macey et al., 2015, 2017). However, there is evidence which suggests that these fabrics may alternatively encompass processes broadly constrained to elevated P-T fields (e.g., Cisneros-Lazaro et al., 2019; Diener et al., 2016; Melosh 2015; Melosh et al., 2014, 2015, 2016, 2018; Young, 2017). Such processes involve high strain rate seismic-cataclasis (involving strain hardening and seismic hydraulic fracturing) and seismic-pumping of meteoric H₂O along localized meso- to macro-scale structural anisotropies within a predominantly ductile to brittle-ductile fluid-undersaturated high strain cores (e.g., Melosh 2015; Melosh et al., 2014, 2015, 2016, 2018; Toogood, 1976; Young, 2017). Field relationships noted by various workers supporting the latter hypothesis is summarised as:

(1) the sparsity of syn-D₄ cataclastic retrogressed fabrics outside of the shear zone core, as well as its discrete localization within it (e.g., Diener et al., 2016; Kartun, 1979; Melosh et al., 2014, 2018; Toogood, 1976),

(2) the considerable correlation between penetrative and reworked D₄ (S₄) fabrics with intrafolial seismic fault breccias, pseudotachylite, and retrograde mineral assemblages within the shear zone core, and concurrent regional scale ductile drag of high- to medium metamorphic grade D₂/D₃ gneisses outside of it (e.g., Diener et al., 2016; Lambert 2013; Melosh 2015; Melosh et al., 2014, 2015, 2016, 2018; Macey et al., 2015; Toogood, 1976; Young, 2017; this study),

(3) Ductile folding of older retrogressed and brittle S₄ fabrics (such as pseudotachylite breccia in a viz. green mica matrix) within ductile dominant high strain zones (e.g., this study),

(4) The absence of progressively overprinting L_4 mineral stretching lineations on a common S_4 foliation (e.g., Angombe 2016; Lambert 2013; Toogood, 1976; this study), and

(5) the relatively narrow ranging but sustained elevated P-T and low fluid (H_2O) saturation conditions constrained for bulk-shearing within the shear zone itself by other workers (e.g., Cisneros-Lazaro et al., 2019; Diener et al., 2016; Toogood, 1976).

Previous studies on the MRPSZ-system by Cisneros-Lazaro et al. (2019), Diener et al. (2016), Lambert (2013), Melosh (2015), Melosh et al. (2015, 2016, 2017, 2018) and Young (2017) all have S_4 as their common structural parameter, and collectively describe positive feedback between progressive S_4 development and syn-tectonic granitic melt emplacement, localised H_2O incursion (retrogression), strain hardening, seismicity (e.g., high strain rate pseudotachylite formation), crystal-plastic deformation of quartz-feldspar rich lithologies (preferential strain nucleation), and large-scale non-coaxial strain localization. These workers illustrate the complexity in the way strain is locally and regionally partitioned and facilitated throughout different portions of the MRPSZ-system.

Toogood (1976) roughly estimated that the MRPSZ-system comprised a 40% simple shear (coaxial) component and a 60 % pure shear (non-coaxial) component. Recent structural work (e.g., Angombe, 2016; Cisneros-Lazaro et al., 2019; Diener et al., 2016; Indongo, 2017; Lambert, 2013; Macey et al., 2015; Melosh 2015; Melosh et al 2014, 2015, 2016, 2018; Young, 2017) suggest that the MRPSZ-system likely comprises a complex three-dimensional combination of coaxial and non-coaxial-, and/or transpressional and transtentional strain domains, as well as a variety of concurrent syn-tectonic brittle to ductile fabrics, which is typical for most crustal scale ductile to brittle-ductile shear zones (e.g., Fossen et al., 2017; Toogood, 1976).

2.5.3 The ORPB, Warmbad Granite Suite, and “quartz-andesine” (leucogranite) intrusions

The E-W trending ~ 400 km long to ~ 45 km wide ORPB (figure 7) is spatially and temporally associated primarily with the regional development of D_4 fabrics between ~ 1040 – 950 Ma (Doggart, 2019; Lambert, 2013; Macey et al., 2015, 2017; Maphumulo, 2020). It comprises > 45 000 mapped granitic pegmatite sills and dikes intruding into various tectono-stratigraphic terranes of the Namaqua-sector of the NNMP (Doggart, 2019; Lambert, 2013; Macey et al., 2015, 2017; Maphumulo, 2020). They are mostly concordant with D_4 fabrics but are also known to locally utilized re-orientated D_2 thrust boundaries (e.g., LFROTZ) as well as regional D_2/D_3 gneissosities (S_2/S_3 ; Doggart, 2019; Macey et al., 2015, 2017). The pegmatites of the ORPB occur as zoned and/or un-zoned, and are dominantly of LCT-type (e.g., Ballouard, 2020; Doggart, 2019, Hugo, 1970, Schutte, 1972), with a small proportion of NYF-type also having described (e.g., Maphumulo 2020). Additionally, a small proportion of the LCT-type pegmatites, notably those occurring within the Vioolsdrift and Pella Domains, have in the past,

and still do, attracted significant economic interest for their endowment in exotic minerals, specifically that of spodumene, Ta-Nb-oxides, lepidolite and beryl (e.g., the Swanson Tantalum Deposit of this study, the neighbouring NTI Tantalite Mine, and the recently explored spodumene deposits of the Steinkopf area; e.g., Hugo, 1970; Minaar and Theart, 2006; Schutte, 1972).

The timing of the ORPB is well constrained, however its origins are still highly enigmatic (e.g., Doggart, 2019; Maphumulo 2020). No parental granite or any single regional structure has been definitively linked to it, and the pegmatites themselves post-date peak (greenschist to granulite) metamorphism within all the tectono-stratigraphic terranes in which they occur (e.g., Doggart, 2019; Maphumulo 2020). Although the ORPB has been directly attributed to D₄, its regional extent and trend follows the regional extent and trend of major D₂ thrust and tectonic klippe structures, namely the Tafelkop Shear, Onseepkans Thrust, LFROTZ and Groothoek Thrust (e.g., figures 7 and 8). This association has led some workers to correlate the ORPB with these structures (e.g., Hugo, 1970; Minaar and Theart, 2006; Schutte, 1972).

Additionally, recent work by Maphumulo (2020) in the Kakamas Domain has illustrated that the age of the ORPB variably overlaps with that of D₃ (e.g., Macey et al., 2015, 2017), suggesting that a temporal link between D₃ and D₄ may exist (also postulated for the study area by Toogood, 1976). Doggart (2019), who studied the broader geochemical and isotopic characteristics of the ORPB across various tectono-stratigraphic terranes, postulated that regional-scale mafic underplating at ~ 1000 Ma (e.g., as potentially inferred for the steep-structure hosted 1.04 Ma Koperberg Suite as occurring within the Bushmanland Subprovince) may have resulted in wide-spread anatexis of deeper portions of all involved tectono-stratigraphic terranes (independent of prior tectono-metamorphic heritage) as a possible origin for the ORPB. He clearly illustrates such a possibility: that locally occurring crustal rocks, irrespective of their unique pre- to syn-D₄ tectono-metamorphic histories, potentially acted as protoliths to locally occurring pegmatites. He further postulated that the distribution of metal-endowment of the LCT- and NYF-type pegmatites throughout various portions of the ORPB likely reflect the metal-endowment of their local anatexis sources.

Lambert (2013) clearly illustrated the mechanisms by which syn-tectonic granitic pegmatite melts have variably utilized D₄ high strain zones (figure 12). Lambert (2013) showed that the mode of pegmatite emplacement within D₄ high strain zones is primarily controlled by the partitioning and distribution of mylonitic (S₄) S-S-C' fabrics and isoclinal intrafolial F₄ fold axial planes within ductile-dominant domains, and by tensional fractures (mode-1 tension fractures, dilatational fault jogs or Riedel-fractures) within more competent brittle- to brittle-ductile dominant domains (e.g., figure 12).

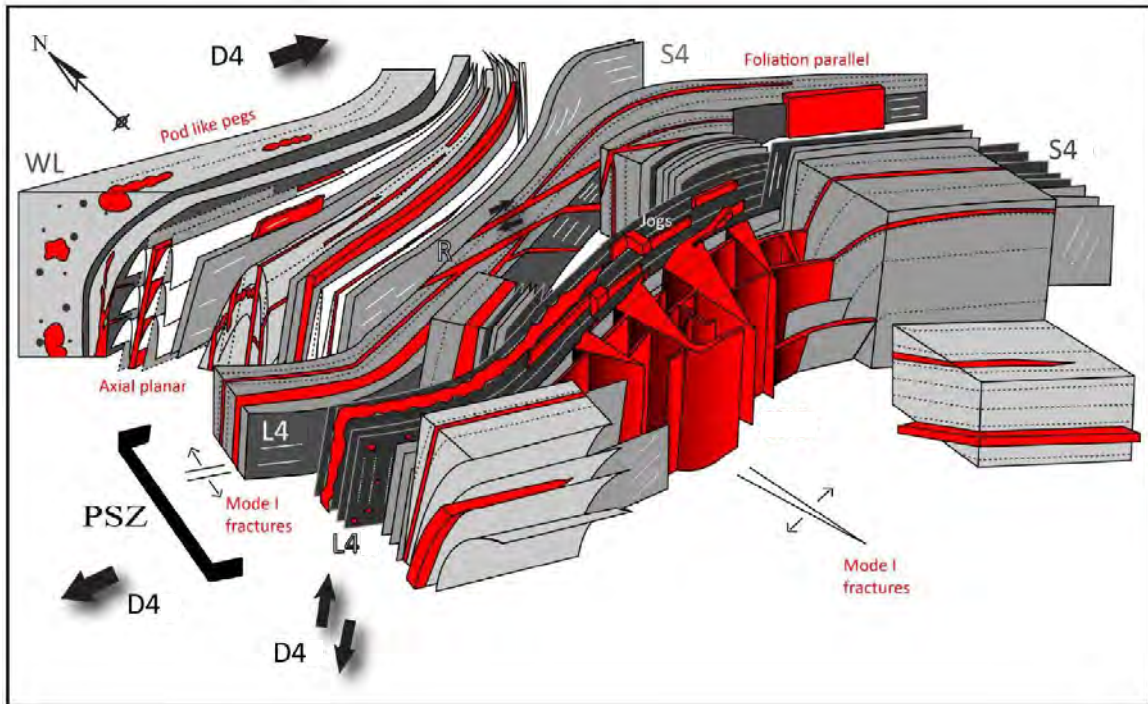


Figure 12: Schematic representation of the various structural controls affecting emplacement of granitic pegmatite melts within D_4 high strain zones modified after Lambert (2013). Note that this representation does not indicate the pervasive reworking of syn-tectonic D_4 fabrics and pegmatites within the high strain zones. The darker grey areas represent higher finite strains, and the lighter grey areas represent lower finite strains. This figure also does not illustrate the variable plunges of L_4 or F_4 on S_4 , or that the plunges of F_4 are commonly in parallelism with the plunges of L_4 .

There are also numerous syn-tectonic leucogranite intrusives occurring as plugs, sills, and dykes, formerly termed as “quartz-andesine intrusives” by Von Backström (1976), which remain largely undescribed in the study area, but are known to be locally associated with the TVC, HMG and MRPSZ. These leucogranites have been mapped as pegmatites and granites of the ORPB and Warmbad Suite (e.g., Doggart, 2019; Macey et al., 2015). The relationship of these locally occurring leucogranites and HMG to D_4 , the TVC, and the ORPB, have never been described in detail, besides for their existence briefly being mentioned in the study area by Kartun (1979) and Von Backström (1976). The leucogranite intrusions will be discussed in more detail in Chapter 4.3.4.2.1.

2.6 Summary of lithologies and structure within the study area

The study area and its immediate surrounds is dominated by penetrative D₄ ductile to brittle-ductile fabrics. Pre-D₄ fabrics are completely transposed and/or reorientated into parallelism with the MRPSZ. The identification of pre-D₄ fabrics within the immediate study area is therefore difficult and unlikely. Distinct late-stage D₅ structures, comprising brittle fracturing, veining and viz. quartz-calcite-epidote-chlorite-alkali-feldspar hydrothermal (propylitic) alteration, crosscuts the D₄ fabric at high angles, however it is not prominently developed or uniformly present. The primary lithologies and structures which occur within the study area comprises lithologies and structures of the D₂ LFROTZ which are pervasively reworked by the D₄ MRSPZ. These are:

- (1) ~ 1.8 Ga Arus Gneiss (reworked by D₂ and D₄)
- (2) ~ 1.2 Ga (?) mixed and hybrid igneous rocks of the HMG and associated xenoliths of the Tantalite Valley Complex proper (early syn-D₂, potentially syn-D₄?).
- (3) ~ 1190 Ma porphyroclastic and sheared granodiorite gneiss of the Kinderzitt Granodiorite belonging to the Eendoorn Suite (late syn-D₂)
- (4) ~ 1040 – 950 Ma (D₄) protomylonite to ultramylonite, cataclasite, phyllonite and sheared rocks, and syn-tectonic (syn-D₄) granitic melts and veins associated with the MRPSZ, which include the pegmatites comprising the Swanson Tantalum Deposit, and
- (5) D₅ minor high-angle late-stage hydrothermal brittle joints, breccias and veins

3 Summary of mineral exploration activity on the Swanson Tantalum Deposit

3.1 Previous exploration

The only historical exploration literature regarding the mineralised pegmatites of the Swanson Tantalum Deposit is Young et al. (1981). They conducted general reconnaissance exploration activities through a Joint Venture (“JV”) between the companies Southern Placer Development (Pty) Ltd. and George Swanson Enterprises (Pty) Ltd. from June to August 1981. During this time, they noted prospective occurrences of minerals of potential economic interest in the area, namely pegmatite-hosted tantalite, microlite, spodumene and lepidolite. They also noted that the pegmatites were locally worked in the past on an artisanal scale for these minerals. Tantalite and microlite, observed to be uniformly present as fine-grained and disseminated crystals throughout all the pegmatites which they investigated, interested them especially. Young et al. (1981) postulated that the reason why artisanal scale mining of tantalum minerals never fully developed or continued in the past is likely the fine-grain size and disseminated nature of the targeted minerals, making crude mechanical beneficiation and recovery of tantalum minerals too challenging for the prospectors active at that time.

After their initial investigations they proceeded to conduct more detailed reconnaissance work and to report what is now considered a Historical Mineral Resource (e.g., JORC, 2012) for the Swanson Tantalum Deposit (table 1). Their follow-up work comprised 189 m of channel sampling across 91 sample locations spread out across several exposed faces of shallow dipping pegmatites (at least 2 m in true thickness) within the Swanson Tantalum Deposit area. The average sample weight of their channel samples was 14.22 kg/sample, or 6.84 kg/m. In addition, a total of 4 bulk samples, each weighing between 3 – 5 tons, intended for high-level mineralogical and metallurgical analyses, were collected over selected areas of interest already covered by their channel samples. This work was accompanied by limited petrographic and field observations and a 1: 2000 scale reconnaissance geological map drawn by compass-and-chain method. The results of their bulk sampling could not be obtained for this study.

The Historical Mineral Resource subsequently reported by Young et al. (1981) comprised 2.54 Mt @ 299 ppm Ta_2O_5 + 79 ppm Nb_2O_5 , at no applied cut-off (table 1), and 0.93 Mt @ 466 ppm Ta_2O_5 + 78 ppm Nb_2O_5 with an applied 300 ppm Ta_2O_5 cut-off (table 2). This Historical Mineral Resource comprised 7 tested pegmatite clusters within the sill-and-dyke swarm occurring within the Swanson Tantalum Deposit area. The seven tested pegmatite clusters, which they named from north-west to south-east, are clusters A, B, C, D, E, F and G. They further subdivided these pegmatite clusters into

eighteen individual pegmatites of primary economic interest, namely pegmatites A1 - A2, B1, C1 - C2, D0 - D2, E1 - E8, F1 and G1. Fifteen of these pegmatites, namely C2, D0 - D2, E1 - E8, F1 and G1 pegmatites occur within the immediate study area (MLAA) and are under current investigation by ORP (this study).

Table 1: Historical Mineral Resource with no cut-off grade applied reported by Young et al. (1981) for the Swanson Tantalum Deposit.

Pegmatite cluster	Estimated tonnage (Mt)	Ta ₂ O ₅ (ppm)	Nb ₂ O ₅ (ppm)	Ta ₂ O ₅ :Nb ₂ O ₅
A	0.67	160	88	1.82
B	0.16	208	60	3.47
C	0.32	197	70	2.81
D	0.73	314	86	3.65
E	0.48	510	60	8.50
F	0.11	539	64	8.42
G	0.07	319	83	3.84
Total	2.54			

Table 2: Historical Mineral Resource, after applying a cut-off of 300 ppm Ta₂O₅, reported by Young et al. (1981) for the Swanson Tantalum Deposit.

Pegmatite cluster	Estimated tonnage (Mt)	Ta ₂ O ₅ (ppm)	Nb ₂ O ₅ (ppm)	Ta ₂ O ₅ :Nb ₂ O ₅
A	0.00	-	-	-
B	0.02	375	116	3.23
C	0.08	301	64	4.70
D	0.32	353	94	3.76
E	0.33	626	69	9.07
F	0.11	539	64	8.42
G	0.07	319	83	3.84
Total	0.93			

Young et al. (1981) noted a remarkable increase in the tantalum tenor and Ta₂O₅:Nb₂O₅ ratio of the pegmatites from the north-west towards the south-east in Swanson Tantalum Deposit area. They suggested that this trend may be proportional with proximity to the Tantalite Valley Complex proper; that pegmatite intruding further away is less endowed in tantalum and pegmatite intruding nearer is more endowed in tantalum. Based on their observations they proposed that the south-eastern most pegmatite clusters, namely E cluster (Ta₂O₅:Nb₂O₅ of 9.07; reported estimated average grade of 626 ppm Ta₂O₅) and F cluster (Ta₂O₅:Nb₂O₅ of 8.42; reported estimated average grade of 539 ppm Ta₂O₅), are of primary economic interest.

Young et al. (1981) recommended that exploratory diamond drilling of the pegmatites be conducted. They also noted that the deposit may be potentially amenable to a small-scale mining operation. However, there is no indication that any such follow-up work ever occurred post-1981.

3.1.1 Unofficial reports by E. W. Evans to George Swanson Enterprises (Pty) Ltd. – 1981

Immediately after the 1981 investigations by Southern Placer Development (Pty) Ltd. and George Swanson Enterprises (Pty) Ltd. (i.e., Young et al., 1981) a Mr. E. W. Evans, who's professional affiliations remain unknown, unofficially reported the existence of significant scheelite occurrences within and adjacent to the Swanson Tantalum Deposit area in a letter addressed to George Swanson Enterprises (Pty) Ltd. In this letter, Evans reports the presence of several scheelite bearing zones, with abandoned artisanal scale workings noted in a north-west to south-east striking zone of about 1.5 km long over a width of approximately 100 m. A significant portion of these identified scheelite bearing zones occurs within the north-western portions of the study area.

Evans described the mineralisation encountered as being “steeply north dipping (80°) greenschist-band hosted quartz veins with finely disseminated blue-white-brown coloured scheelite, interbedded with highly sheared granites (up to 10 m thick) and cross-cut by late-stage pegmatites (up to 2 m thick)”. In a 4-ton metallurgical bulk sample collected by Evans a recovery of 0.5 – 0.75 % scheelite was reported.

In Evans's letter he proposed a potential follow up program which included exploratory diamond drilling of the identified prospective area, however there is no indication that such work ever occurred. To date ORP has not investigated the scheelite potential of the Swanson Tantalum Deposit area.

3.1.2 The Tantalite Valley Mine (now the Namibian Tantalite Investment Mine)

There is no indication that the previous or current owners/workers of the NTI mine ever conducted exploration work for pegmatite-hosted minerals within the Swanson Tantalum Deposit area.

3.2 Present mineral exploration

There is no indication that any exploration activities have taken place within the Swanson Tantalum Deposit area by subsequent companies or interested parties between 1981 to 2017.

ORP, who initially identified the area as a prospective regional exploration target for lithium and tantalum mineralisation in 2016, mainly based on the work of Young et al. (1981), applied for EPL 5047 at the Namibian Ministry of Mines and Energy in 2017. They were subsequently granted the EPL in early-2018. Since 2018, the Swanson Tantalum Deposit area has undergone, and is still subject to, intensive exploration activities by ORP (<https://arcadiaminerals.global/>). ORP has since adopted the naming of individual pegmatites as in Young et al. (1981).

3.2.1 Litho-structural mapping

The MLAA (study area) is wholly covered by the 1: 50 000 scale geospatial datasets of the Namibian Geological Series Sheet 2818 (Warmbad; e.g., Macey et al., 2015) and partially covered by the 1: 2000 scale reconnaissance mapping of Young et al. (1981). 1: 1000 scale litho-structural mapping conducted by ORP (this study), which employed unmanned aerial vehicle (“UAV”) surveying (e.g., high resolution digital elevation models and ortho-photo mosaics), covers the portions of the MLAA hosting clusters C, D, E, F and G. Figure 13 indicates the various mapping programs which have occurred over the Swanson Tantalum Deposit and study area to date.

3.2.2 Sampling and drilling

ORP has to date collected a total of 433.76 m ($n_{\text{channel samples}} = 277$ at an average sample interval of 1.57 m) of top-to-bottom face channel sampling, 343.44 m of HQ-size diamond core drilling ($n_{\text{drill holes}} = 23$), with 104.32 m of pegmatite intersection ($n_{\text{drill core samples}} = 104$ at an average sample interval of 1.00 m and average weight of 4.3 kg/half-core sample), 78 (6 – 8 kg) rock chip samples and a 5.5-ton metallurgical and mineralogical bulk sample of the pegmatites of primary economic interest (i.e., of clusters C, D, E, F and G; figures 13 and 14). The pegmatites which ORP sampled and drilled were also sampled by Young et al. (1981), and therefore ORP was able to conduct basic due diligence during its exploration program. The sampling results of ORP and Young et al. (1981) were comparable and showed reproducibility at selected sample localities (Le Roux et al., 2020).

Top-to-bottom channel sampling of exposed pegmatite faces, which comprises an intensive portion of ORP’s exploration work (i.e., high pegmatite intersection meterage), was conducted at either 10 – 20 m or 20 – 30 m along-strike intervals by cutting 8 – 12 cm wide channels with a diamond-blade grinder, chipping out fragments with a hammer and chisel and then weighing the collected material (e.g., figure 15A). Where possible, channel sampling was executed in a way where recovered sample material would approximate the weight, width, and intersection length of that which would have typically been recovered from a HQ-PQ size (63.5 – 85 mm diameter) diamond core intersection. Overall, only pegmatites with a true thickness of > 1 m were sampled, and where pegmatites had a true thickness of > 2 m the channel samples were accordingly split into an equal length “top”, “middle” and “bottom” channel samples as required.

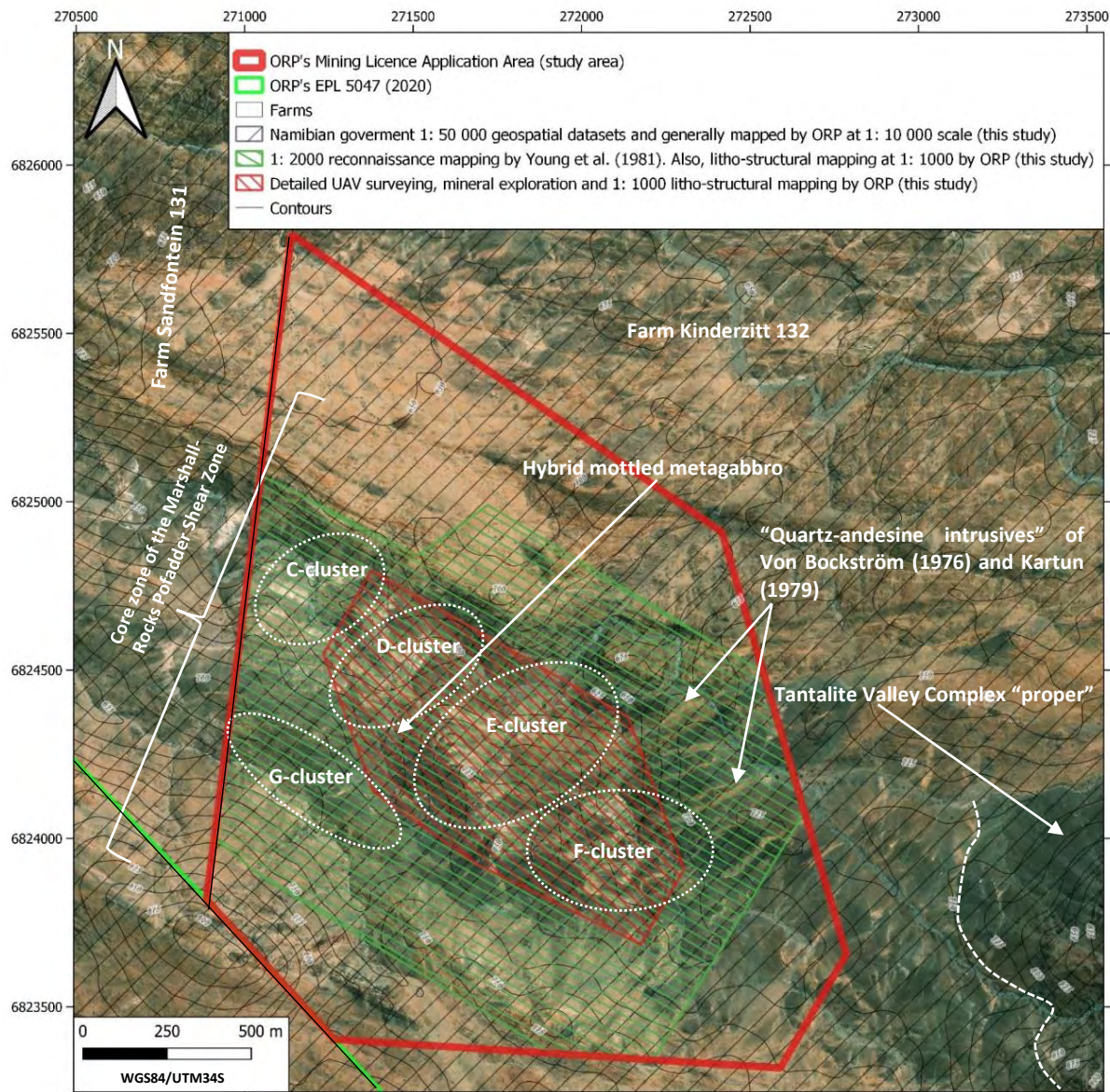


Figure 13: Overview of the various mapping programs and major geological markers which cover the study area.

None of the samples collected by ORP were constrained to any specific internal mineralogical or textural zonation within the pegmatites of economic interest, as ORP, and several industry consultants working on the project at the time, prioritised the importance of bulk-pegmatite properties for reasons related to the economic feasibility of the project (Hattingh, 2020; Le Roux et al., 2020). Therefore, all sampling results were composited (i.e., weighted average for the entire pegmatite intersection) to yield a total intersection estimate for any specific location of the pegmatite face which was sampled (i.e., drilled/channelled, or chipped; Hattingh, 2020; Le Roux et al., 2020; Mullins and Petzer, 2021). Where possible, all ORP's samples were surveyed as down-hole intervals and/or down-hole events for 3D-geological modelling purposes (i.e., X, Y, Z coordinates and from/to intervals for Geosoft Target™ software).

All exploration samples were submitted to Scientific Services (Pty) Ltd. laboratories in Cape Town, South Africa, or to Activation Laboratories Ltd, in Windhoek, Namibia, and Ontario, Canada. All samples were subject to Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) analysis mainly for Ta, Nb and Li contents only.

High-level metallurgical and mineralogical characterization of the pegmatites and tantalum mineralisation was conducted by third party contractors on the 5.5-ton bulk sample (Chapter 5.5.1). Currently a 100-ton bulk sample is being investigated with the aim of designing a commercially viable process flow plan for the beneficiation and extraction of tantalum minerals.

ORP is currently in the process of a second phase of HQ-size diamond core drilling campaign comprising a planned total meterage of 1200 – 1400 m (e.g., figure 14).

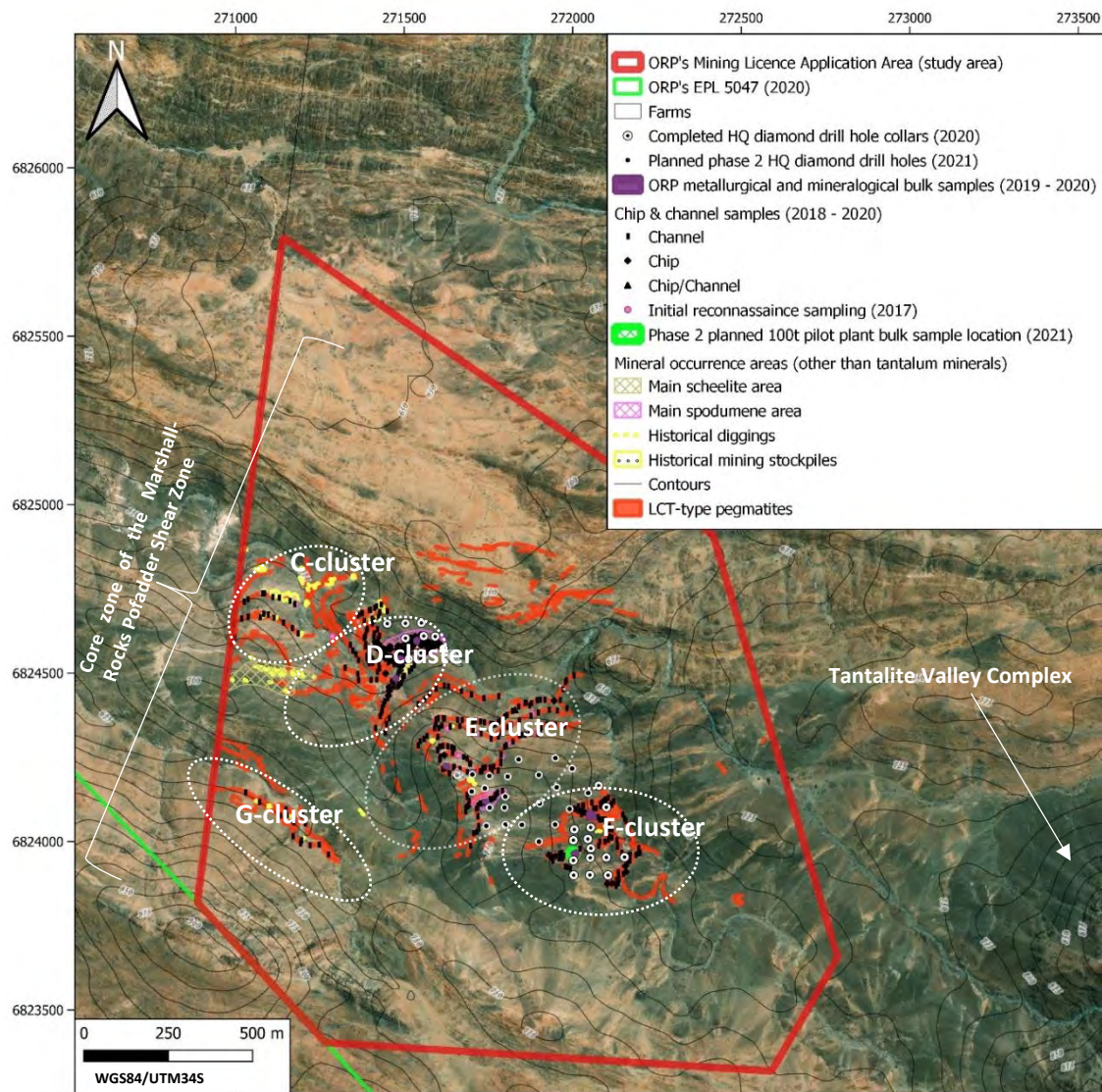


Figure 14: General overview of all ORP's mineral exploration work which has been conducted over the Swanson Tantalum Deposit area to date.



Figure 15: Examples of various exploration activities conducted by ORP on the Swanson Tantalum Deposit to date. **A** - Channel sampling. **B** - Rock-chip sampling. **C** - HQ diamond core drilling. **D** - HQ diamond core drilling. **E** - HQ diamond core logging and sampling. **F** - HQ diamond core logging and sampling in ORP's on-site core yard.

4 Litho-structural inventory of the study area

4.1 Introduction

The litho-structural inventory of the study area presented here depends heavily on photographic evidence and field descriptions and measurements of rock outcrops, structures, and their crosscutting relationships. No detailed petrographic, mineralogical and/or geochemical work, except for that which forms part of the ORP's exploration activities on the Swanson Tantalum Deposit, was undertaken. It incorporates the relevant petrographic and geochronological observations of previous authors (e.g., Lambert, 2013; Macey et al., 2015, 2017; Kartun, 1979; Toogood, 1976; Von Backström, 1976; Young et al., 1981). However, as will be pointed out in this chapter, there is significant scope to better constrain the geochronological framework of the study area, specifically with regards to the timing of various locally occurring D₄ components (e.g., the ages of various syn-tectonic melts and associated tectonic rocks).

4.2 Subdivision of the study area as based on structure and lithology

Within the study area D₄ fabrics exhibit varying orientations and degrees of strain localisation and partitioning (i.e., mylonitisation and L-S tectonite formation), and mode and frequency of associated syn-tectonic granitic melt emplacement. The variability observed within the study area appears to depend on the spatial distribution of primary lithologies within the context of the MRPSZ and proximity to the TVC proper. Due to these characteristics being realised the study area has subsequently been subdivided into various domains as based on the prevailing lithological and structural characteristics of each. These are domains A, B, C1 – C4, and D (figure 16).

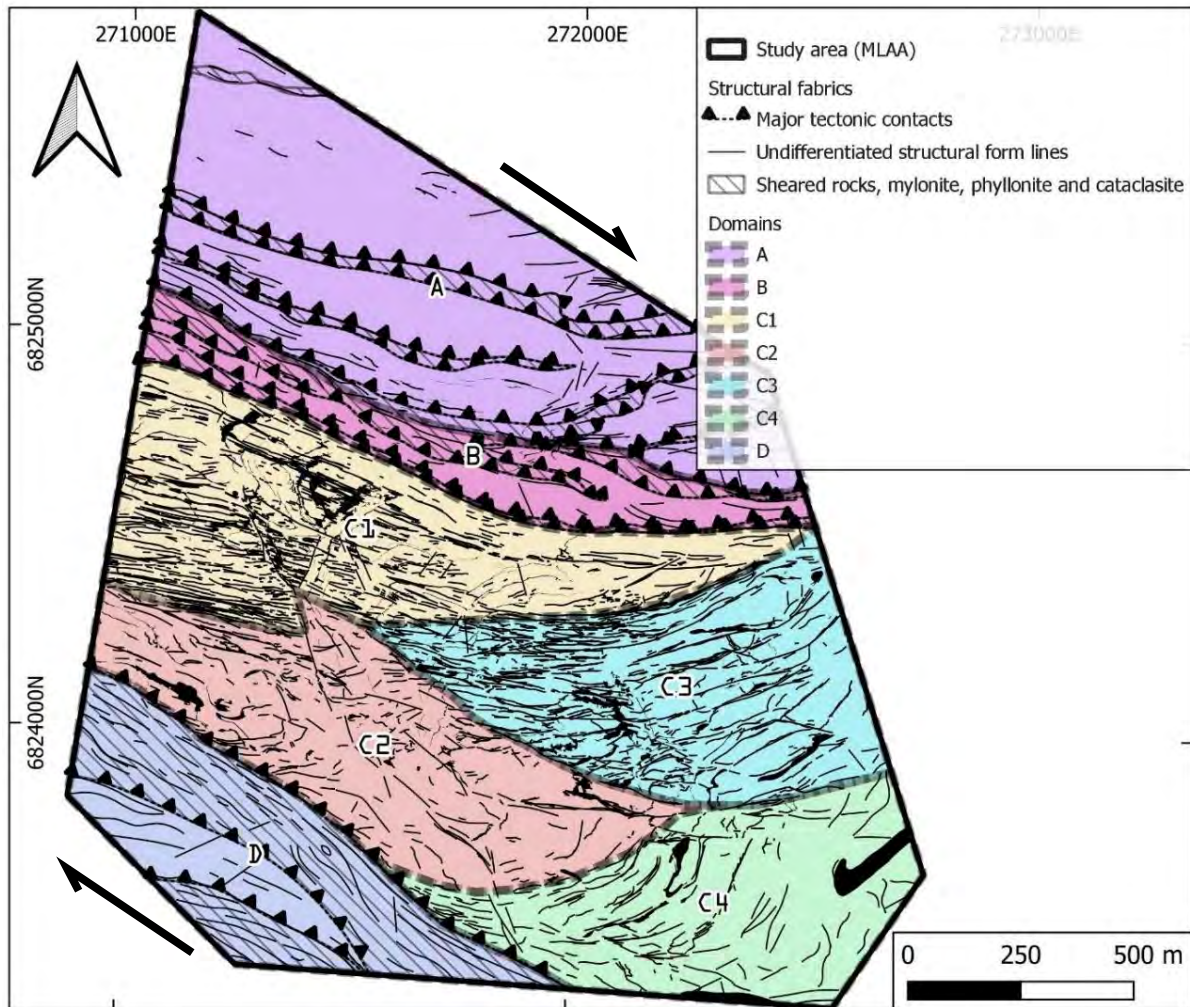


Figure 16: Map indicating the various domains into which the study area has been subdivided as based on the overall lithological and structural characteristics of each.

Domains A, B and D exhibit relatively high strain as compared to domains C1 – C4 which exhibit relatively low strain. Domains C1 – C4 comprise sub-domains of the HMG and domains A, B and D are comprised of granodiorite, granulite, and large zones of undifferentiated tectonic rocks. A total of 1080 structural measurements of various D₄ structural fabrics and related rocks have been collected and have been sub-classified according to the domains under which they fall. Thus, qualitative statistical structural analysis is conducted per domain to adequately highlight the variability between domains (e.g., Chapter 4.4.). The various structural fabrics and their applied field codes are presented in table 4.

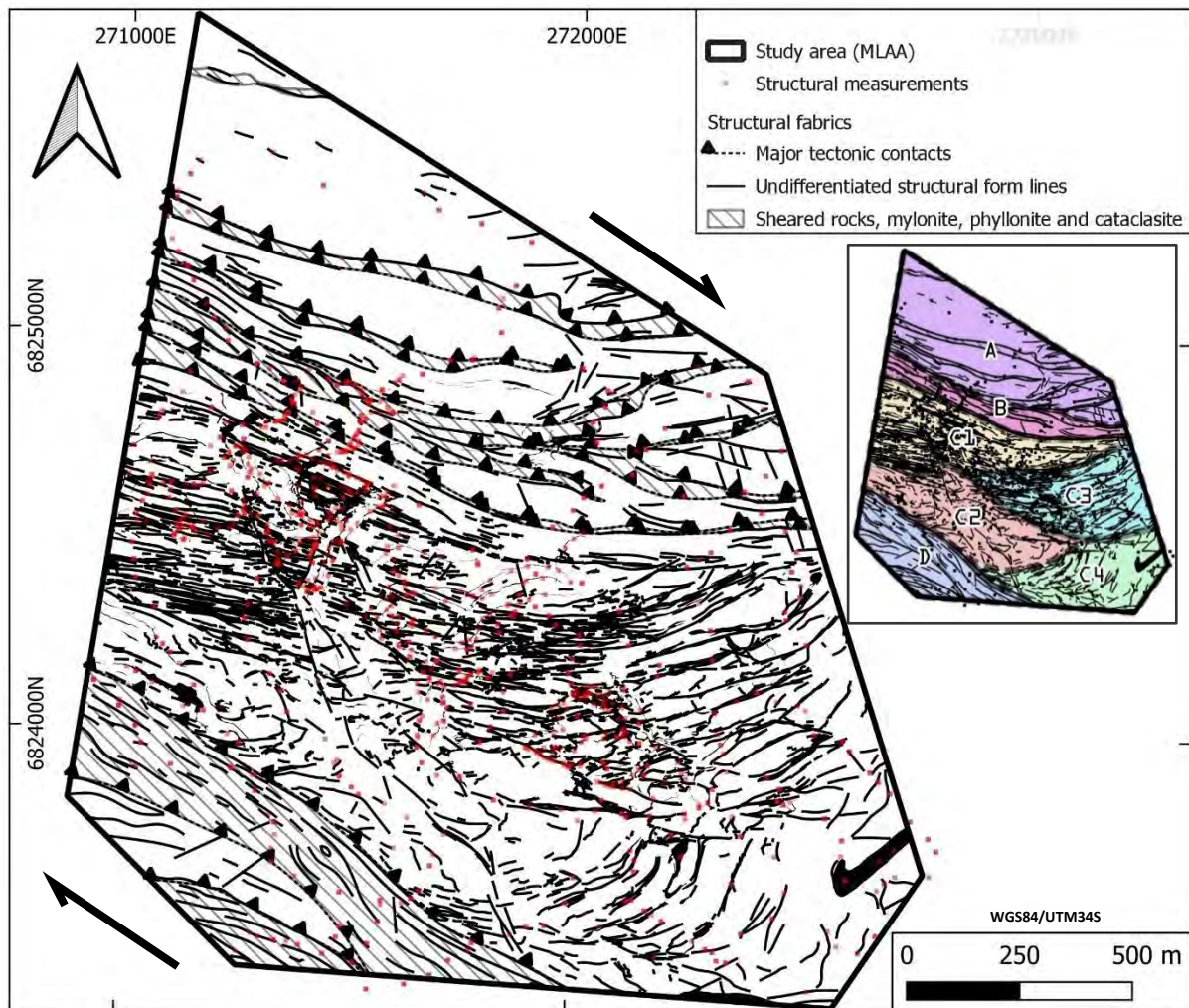


Figure 17: Structural form line map of the study area indicating undifferentiated D_4 structural fabrics as well as the locations and distributions of structural measurements collected.

An overview of the litho-structural inventory of the study area, as will be discussed in more detail in Chapters 4, is presented in figures 16 - 18 and in tables 3 - 4.

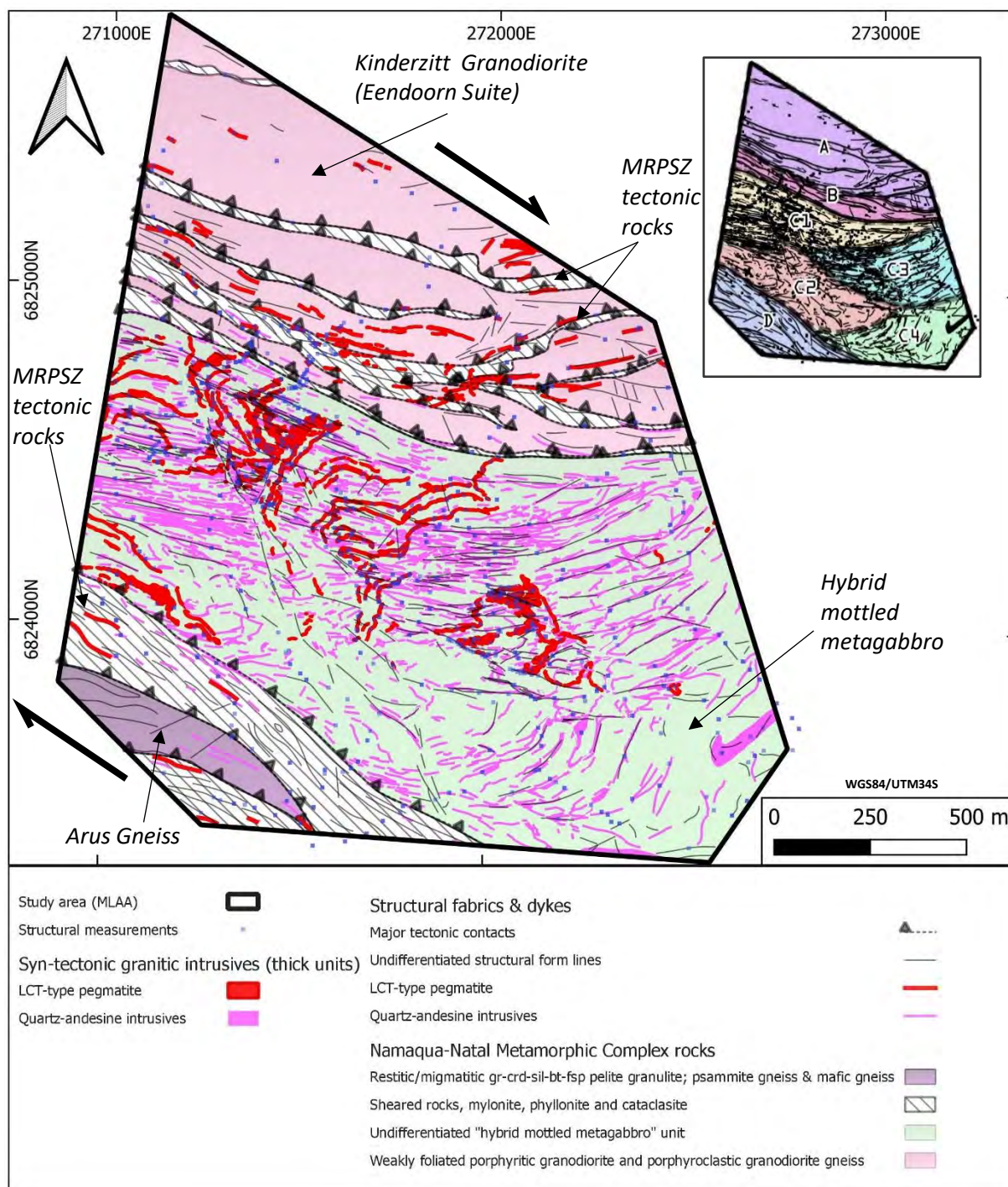


Figure 18: A map indicating the general lithological inventory of the study area with focus on the distribution of locally occurring pegmatites of the ORPB.

Table 3: An overview of the lithological inventory of the study area as based on a combination of field observations made during this study and other descriptions from relevant sources. The ages assigned to the various lithologies are also derived from relevant sources. They HMG is here regarded as being syn-D₄ in age and not as being part of the ~ 1.2 Ga Kum Kum Suite.

Associated deformation episode	Assigned Age	Suite / Group / Formation / Unit	Lithology (in study area)	Primary references
D ₁	<1828 Ma	Arus Gneiss (Chapter 4.3.1)	Restitic/migmatitic grt-crd-bt-fsp pelite granulite; psammite gneiss and mafic granulite	Beukes (1973), Macey et al. (2015, 2017), Kartun (1979), this study
D ₂	~ 1212 Ma	Kum Kum Suite (Tantalite Valley Complex proper)	Xenoliths of gabbroic-dominant rocks and minor pyroxenite, troctolite, tonalite; metamorphic equivalents thereof; within the intrusive “hybrid mottled metagabbro” unit	Macey et al. (2015, 2017), Moore (1975), Kartun (1979), Von Backström (1976), this study
		Kinderzitt Granodiorite of the Eendoorn Suite (Chapter 4.3.2)	Unsheared to weakly sheared porphyritic granodiorite; porphyroclastic granodiorite augen gneiss	Macey et al. (2015, 2017), Kartun (1979), Toogood (1976), this study
D ₄	~ 1040 – 950 Ma (Possibly older?)	“Hybrid mottled metagabbro” unit (Chapter 4.3.3)	Mixed, sheared to weakly sheared, complex, hybrid “mottled” finer grained melanocratic and coarser grained leucocratic igneous rocks; intrusive into the Tantalite Valley Complex (and Kinderzitt Granodiorite?)	Macey et al. (2015, 2017), Kartun (1979), Von Backström (1976), Toogood (1976), this study
		Tectonic rocks of the MRPSZ and associated syn-tectonic granitic melts and veins (Chapter 4.3.4)	Protomylonite to ultramylonite, cataclasite, phyllonite and sheared rocks; LCT-type pegmatites, medium-grained and partially mylonitised equigranular leucogranite sills, dykes, and plugs (“quartz andesine intrusives”) and viz. phyllonite hosted quartz-feldspar-biotite-amphibole-scheelite veins	Lambert (2013), Daggart (2019), Macey et al. (2015, 2017), Kartun (1979), Toogood (1976), Young et al. (1981) this study
D ₅	> 950 Ma?	Post-D ₄ brittle joints and veins (Chapter 4.4.5)	Brittle fracturing, veining with viz. quartz-calcite-epidote-chlorite-alkali-feldspar hydrothermal alteration	Macey et al, 2015, Toogood (1976), this study

Table 4: An overview of the structural inventory of the study area and the various structural fabrics measured. The field codes of the structural fabrics, as will be used throughout this study, are indicated.

Associated deformation episode	Structural fabric	Structure type	Description (and applied field code)
D ₄	Linear fabrics (plunge and plunge directions)	Mineral stretching lineations and slickensides	On mylonitic and gneissic foliations (L₄) – in Domains A, B and D
			On mylonitic foliations (L₄) – in domains C1, C2, C3 and C4
		Fold hinges	On vein contacts (QVCL₄) – All domains
			Pegmatite fold hinges (PCF₄) – ind C1, C2, C3
	Planar fabrics (dip and dip directions)	Pegmatite contacts	Fold hinges of intrafolially folded S ₄ mylonitic foliation (F₄) – All domains
			Pegmatite intrusive contacts (PC₄) – in domains A, B and D
		Foliations	Pegmatite intrusive contacts (PC₄) – in domains C1, C2 and C3
			Mylonitic and gneissic foliations (S₄) – in domains A, B and D
D ₇	Planar fabrics (dip and dip directions)	Fault planes	Mylonitic foliations and associated "quartz-andesine intrusive" contacts (S₄) – all domains
			On vein contacts (QVC₄) – all domains
D ₅		Brittle-ductile fault/shear plane	Normal fault planes (NFC₇) – all domains
			Hydrothermal veins/breccia contacts (HBRC₅) – all domains

4.3 Lithological units

4.3.1 Arus Gneiss

The rocks of the Arus Gneiss (Beukes, 1973; Macey et al., 2015) are the oldest and highest metamorphic grade within the study area (Macey et al., 2015). They are restricted to domain D where they occur as an allochthonous lithon bound within relatively thick high strain zones of undifferentiated felsic ultramylonite, mylonite and cataclasite. The Arus Gneiss is regionally described as dominantly restitic/migmatitic grt-crd-bt-fsp pelite granulite, psammite gneiss, and leucogranite with minor amphibolite and calc-silicates of uncertain origin (Beukes, 1973; Macey et al., 2015). Within the study area the Arus Gneiss is expressed as a rock unit exhibiting diagnostic textures of wispy “older” and restitic paleosomes and “younger” granitic leucosomes, with the more mafic paleosomes commonly accompanied by unusual granoblastic calc-silicate minerals viz. epidote, green pyroxene (diopside?), green amphibole (actinolite-tremolite?) and garnet (figure 19). It generally exhibits a very weak structural fabric and mostly appears to retain original anatectic textures, although variably aligned with the structural fabric of the MRPSZ. It defines a topographically prominent body within the study area and typically weathers to a patched creamy yellow-maroon-brown colour.

Domain D and encompassed Arus Gneiss and tectonic rocks are not associated with high frequencies of syn-tectonic granitic melts. Where present these melts are typically small in width and are not laterally continuous and are predominantly concordant within the tectonic rocks surrounding the Arus Gneiss lithon.

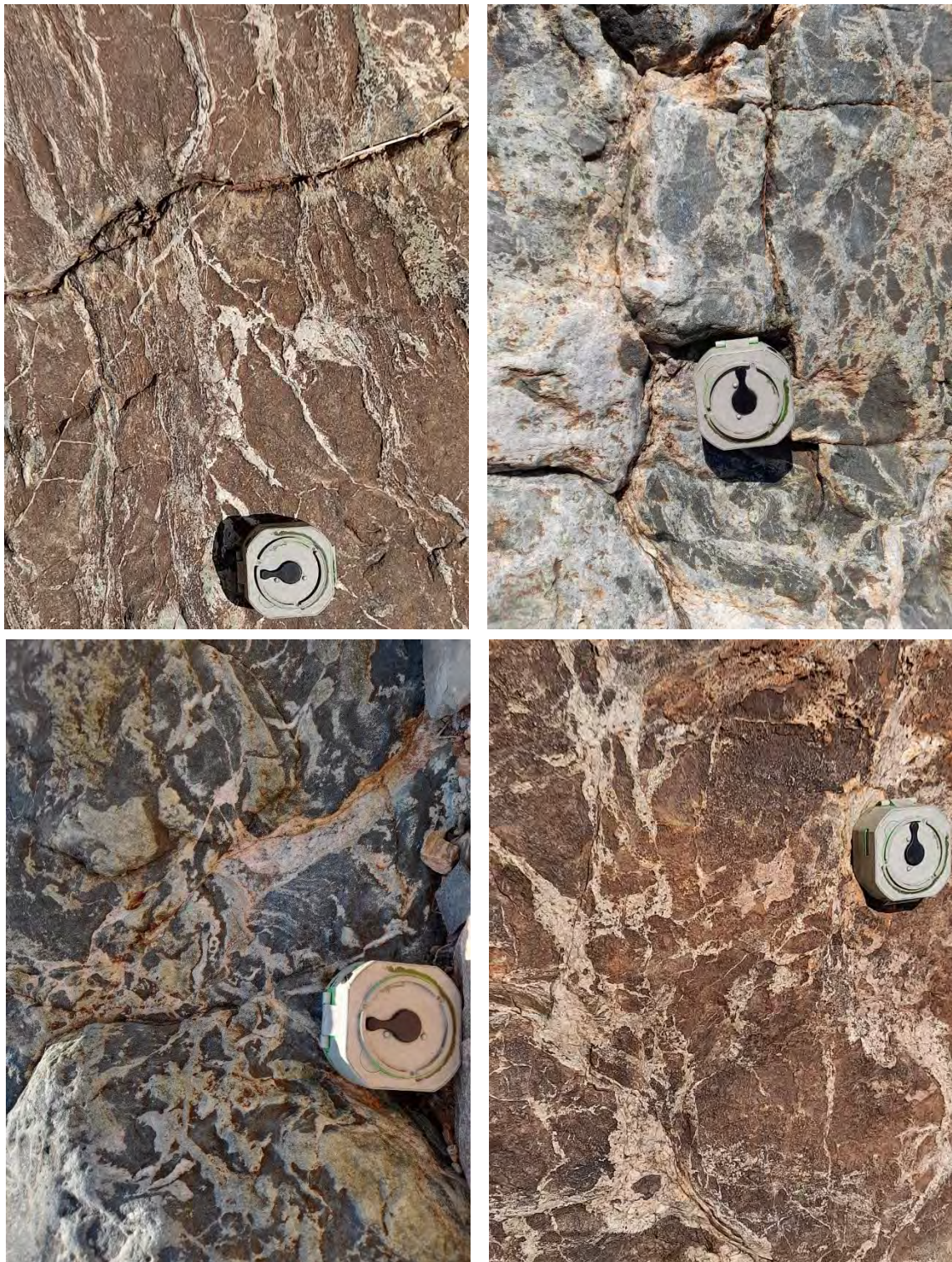


Figure 19: Examples of wispy older restitic paleosomes and younger granitic leucosomes which comprise the Arus Gneiss within the study area. The mafic paleosomes often exhibit unusual calc-silicate mineralogy, viz. epidote, green pyroxene (diopside?), green amphibole (actinolite-tremolite?) and garnet.

4.3.2 Porphyritic granodiorite and porphyroclastic granodiorite gneiss (Kinderzitt Granodiorite of the Eendoorn Suite)

Domains A and B are exclusively comprised of weakly sheared to sheared porphyritic granodiorite and mylonitic porphyroclastic granodiorite gneiss. These rocks belong to the ~ 1190 Ma Kinderzitt Granodiorite of the Eendoorn Suite (e.g., Kartun, 1979; Macey et al., 2015, 2017). It appears as a massive, homogenous, and relatively coarse-grained inequigranular rock with pink-green colouration and diagnostic tabular to ovoid microcline feldspar phenocrysts (e.g., Kartun, 1979; figure 20). Quartz, biotite, and minor garnet can also be observed. The distribution of megacryst concentrations throughout the rock appears to be varied, with some areas containing very high concentrations, and others containing very low concentrations. Xenoliths comprising schist, gneiss and amphibolite are also rarely encountered.

The main difference between domains A and B for this rock type is the degree of shearing and mylonitization (e.g., figures 20– 22). The contact between the Kinderzitt Granodiorite and the HMG is tectonic and is defined by a relatively thick and continuous zone of protomylonite to ultramylonite (e.g., figures 21 - 22). This mylonite zone defines domain B. Within domain A mylonitization is much less prevalent, however the Kinderzitt Granodiorite can be seen to be sub-portioned into aggregates of large-scale ovoid lithons bound by anastomosing mylonite zones.



Figure 20: Weakly sheared porphyritic granodiorite gneiss of the Kinderzitt Granodiorite in domain A.



Figure 21: Protomylonitic to ultramylonitic granodiorite gneiss with S- C fabric of the Kinderzitt Granodiorite in domain B.

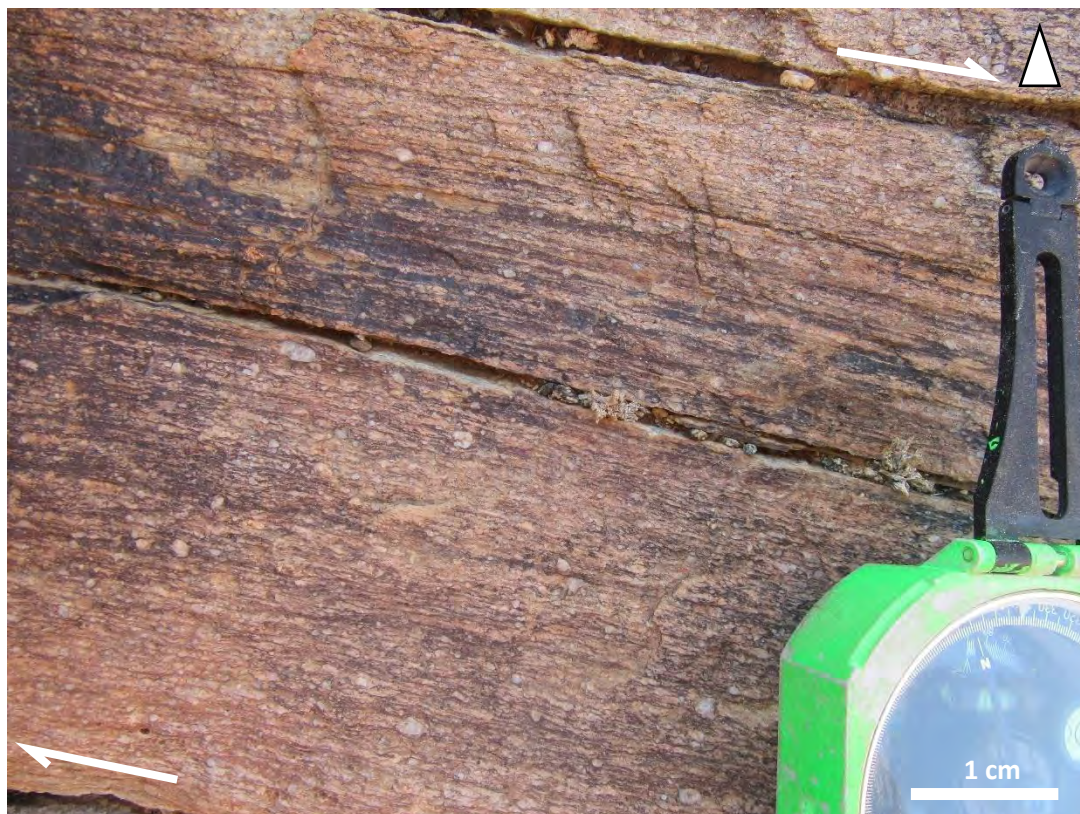


Figure 22: Mylonite after granodiorite gneiss of the Kinderzitt Granodiorite in domain B.

4.3.3 The “hybrid mottled metagabbro”

Most of the study area is underlain by a NW – SE trending ~ 4 km by 800 m body of mixed leucocratic and melanocratic igneous rocks of variable composition and texture – the HMG. This body resembles an elongated spur or tail which extends from the north-western contact of the TVC proper towards the Houms River where it terminates (e.g., Macey et al., 2015; Kartun, 1979). It is tectonically bound by porphyritic granodiorite and porphyroclastic granodiorite augen gneiss of the Kinderzitt Granodiorite to the northeast, and chiefly by tectonic rocks of the MRPSZ and allochthonous rocks of the Arus Gneiss to the southwest. It comprises domains C1 – C4. Within the context of the MRPSZ it is rheologically more competent than domains A, B, and D (e.g., figures 16 - 18). Its boundary contacts are marked by the sudden appearance of generally NE dipping and relatively thick zones comprised of continuous undifferentiated mylonite and subordinate pseudotachylite (e.g., domain B). Its interior is chiefly associated with relatively high frequencies of syn-D₄ granitic melts (pegmatites and leucogranites) and discrete mylonite and phyllonite zones with sharp contacts. The LCT-type pegmatites which comprise the Swanson Tantalum Deposit are bound within this body.

The melanocratic components, which are dominantly fine- to medium-grained and exhibit sporadic “floating” phenocrysts, are volumetrically dominant, while the leucocratic components, which are dominantly medium to coarse-grained, inequigranular and sometimes even megacrystic, are volumetrically subordinate. There are numerous instances of coarser grained and distinctly gabbroic material being present, however these occur strictly as xenoliths. Overall, the unit can be identified by its distinctive dark-grey and “spotted” or “mottled” appearance, and by a mafic-dominant expression commonly defined by large aggregates of finer grained melanocratic “enclaves” within interstitial coarser grained leucocratic material (e.g., figures 23 - 26). There are instances where the leucocratic and melanocratic components appear to be true mixed hybrids (e.g., figure 26A). The unit weathers negatively relative to the rocks of the TVC proper, as well as the rocks comprising domains A, B and D.

Kartun (1979) briefly described the melanocratic components as inequigranular textured rocks with 0.7 – 4.0 mm rounded glomero-megacrysts of plagioclase and blueish quartz often exhibiting corona-like reaction rims (e.g., figure 26A). Kartun (1979) also described the rock’s matrix as consisting primarily of hornblende and plagioclase which sometimes exhibit relict ophitic textures, and of secondary chlorite, sericite, prehnite, and epidote. In areas where magma mingling is strongly developed hornblende can be seen to be altered to chlorite and biotite. The representivity of descriptions by Kartun (1979) should be perceived with some scepticism as the rock types comprising this body are extremely diverse and would require a large sample selection to accurately describe its petrographic inventory.

There are no current detailed petrographic descriptions of the coarser grained leucocratic components except for that they *possibly* represent Eendoorn Suite melts (e.g., Kartun, 1979; Macey et al., 2015, 2017). It is uncertain whether associated feldspar phenocrysts and megacrysts are plagioclase or alkali-feldspar, and/or if they may even represent magmatically scavenged xenocrysts. In some instances, rounded and zoned felspar megacrysts can be observed to be “floating” within the matrix of the fine to medium-grained melanocratic material, and thus can reasonably be assumed to represent alkali-feldspar xenocrysts (e.g., figures 25 - 26).

In areas where magma mingling is strongly expressed it appears as if melanocratic and leucocratic melts have intruded contemporaneously to shearing, as also alluded by Kartun (1979) and Macey et al. (2015). An alignment of larger feldspar phenocrysts within leucocratic components and of melanocratic “enclaves” appear to preserve a syn-magmatic fabric which is exclusively sub-parallel to S_4 (e.g., figures 23, 24, 25B and 26B). In general, a weakly to moderately developed S_4 structural fabric is present throughout the HMG, with higher strain zones being discretely developed and not being penetrative or pervasive throughout. Overall, the HMG exhibits low strain relative to the surrounding rocks comprising domains A, B and D.

Although not occurring directly within the study area, dykes of *viz.* HMG are observed to intrude into the gabbroic rocks of the TVC proper (e.g., figure 27), as well as into sheared porphyroclastic granodiorite gneiss of the Kinderzitt Granodiorite (e.g., figure 28). In such instances the dykes clearly exploit the S_4 foliation and are sometimes overprinted by it. These dykes are commonly composed of a finer grained melanocratic matrix with “floating” feldspar phenocrysts (xenocrysts?), more rarely with mafic “enclaves”, and often have leucocratic (*viz.* granitic) segregations occurring towards their contact margins (e.g., figures 27 and 28). Sometimes these granitic segregations can be seen to transgress the contact margins of the dykes so that they represent new granitic and/or pegmatitic apophyses (figure 27). These granitic segregations in many instances appear texturally like the leucogranite (quartz andesine intrusives) intrusions.



Figure 23: HMG - magma mingling textures produced by the mixing of melanocratic and leucocratic melts. The finer grained melanocratic “enclaves” with interstitial coarser grained leucocratic material can be seen. This is a relatively low strain area within domain C1, however a possible faint magmatic fabric sub-parallel to S_4 can still be observed.



Figure 24: HMG with definitive gabbroic xenoliths presumably belonging to the TVC proper.



Figure 25: **A** – rare megacrystic alkali feldspar xenocrysts with very weakly developed magmatic fabric sub-parallel to S_4 . **B** – Magma mingling textures produced by the mixing of melanocratic and leucocratic melts. The aspect ratios of the “enclaves” also seem to indicate a magmatic fabric relative to the leucocratic melts which surround them, and which appear relatively unstrained.

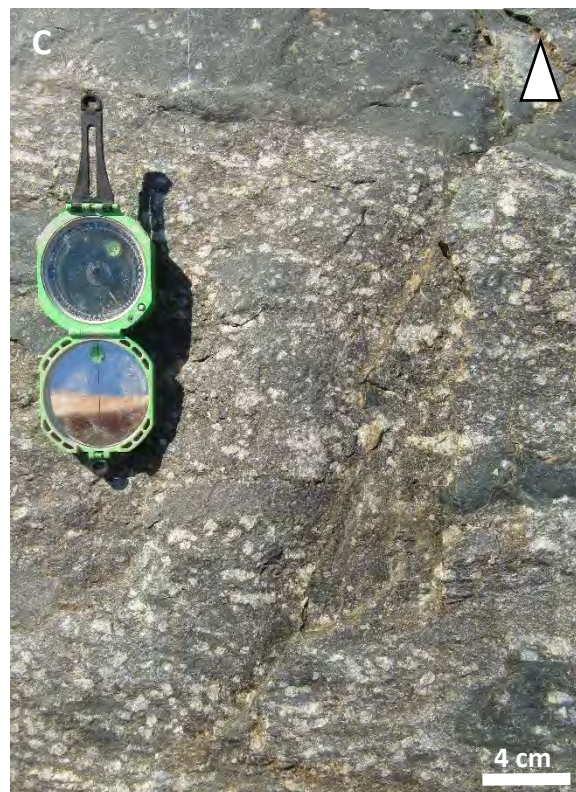
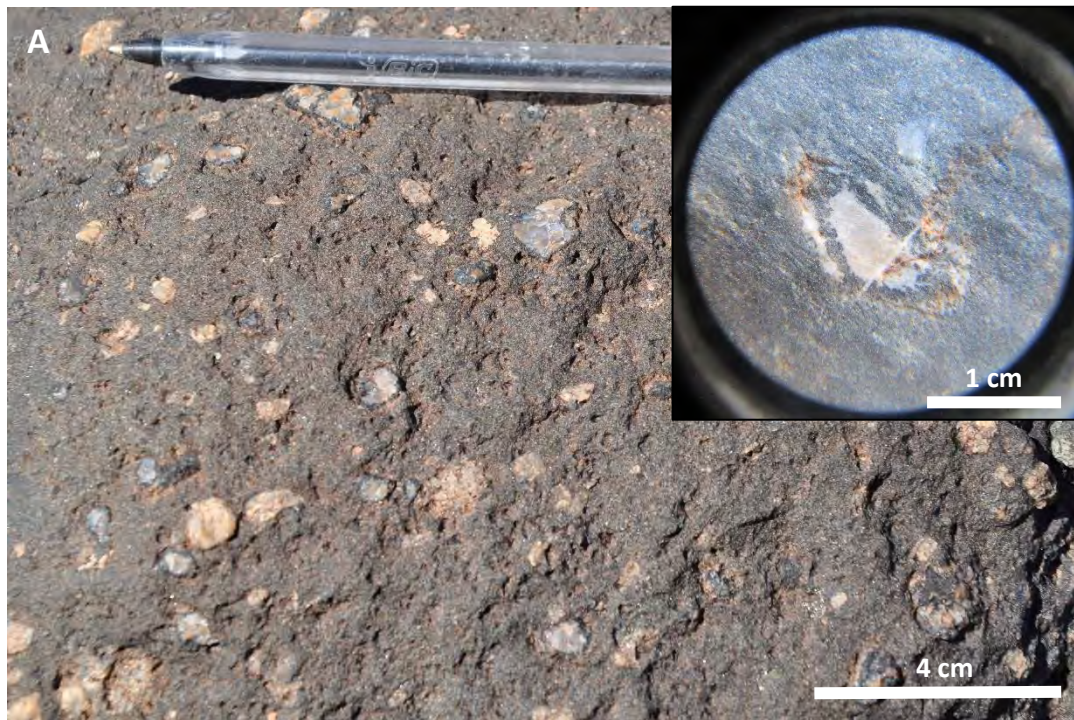


Figure 26: **A** – Fine-grained inequigranular texture of melanocratic-dominant portions of the HMG showing quartz and plagioclase phenocrysts with a weakly defined reaction rim. **B** – Magma mingling texture produced by mixing of melts. In this outcrop it also appears as if a magmatic fabric defined by elongated mafic enclaves is preserved. **C** – extensively mixed HMG showing a true hybridized melt.

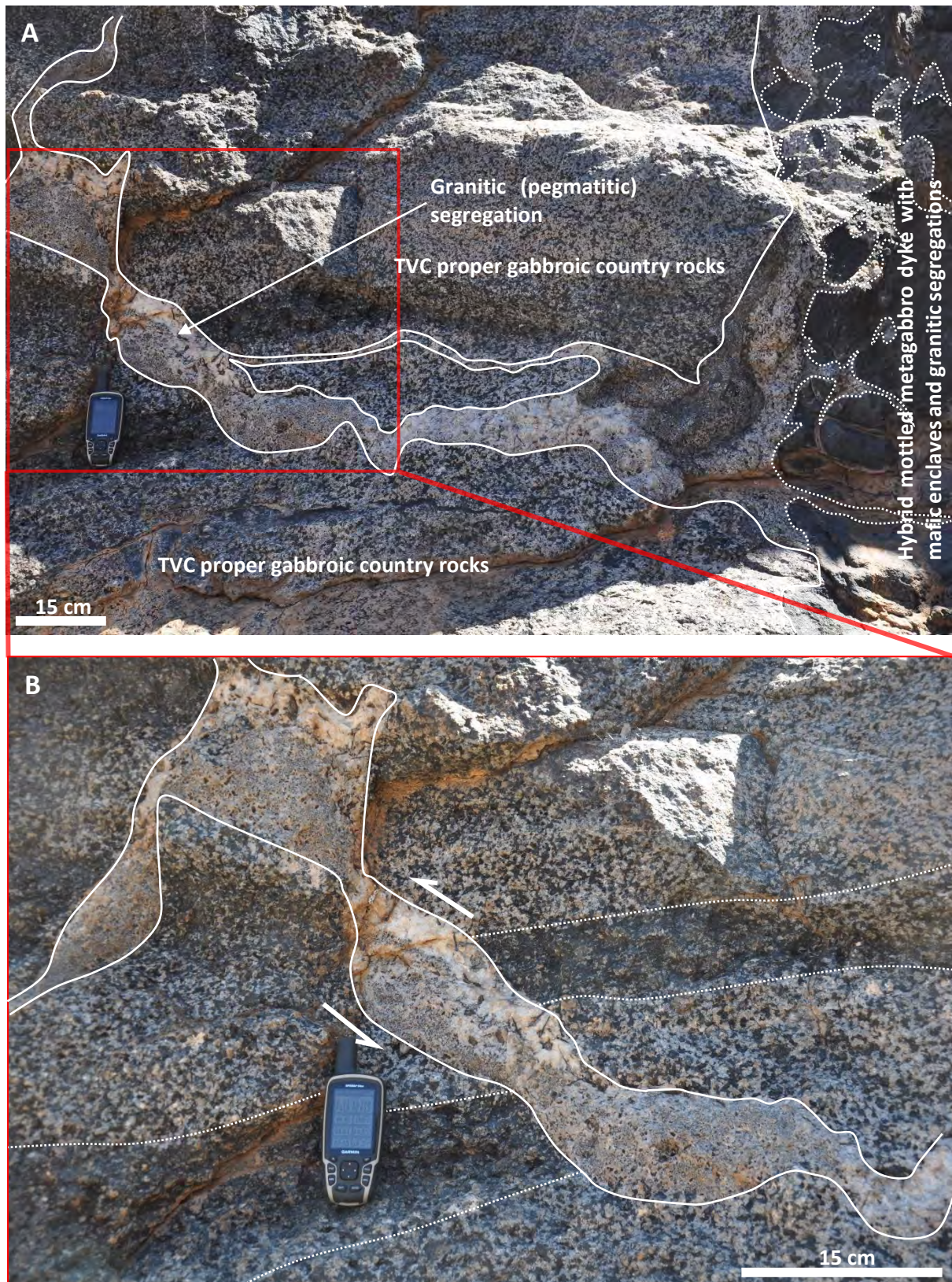


Figure 27: **A** - Dykes of viz. HMG crosscutting coarse-grained gabbroic rocks of the TVC proper. The magma-mingling textures within the main portions of the dyke are still clearly visible. The melanocratic "enclaves" retain "floating" phenocrysts, and the leucocratic components are coarser grained and volumetrically subordinate. Granitic segregations can be seen to comprise individual granitic/pegmatitic apophyses. **B** – A granitic/pegmatitic apophysis which stems off the main viz. HMG dyke can be seen to offset primary magmatic layering within the gabbroic rocks of the TVC proper.

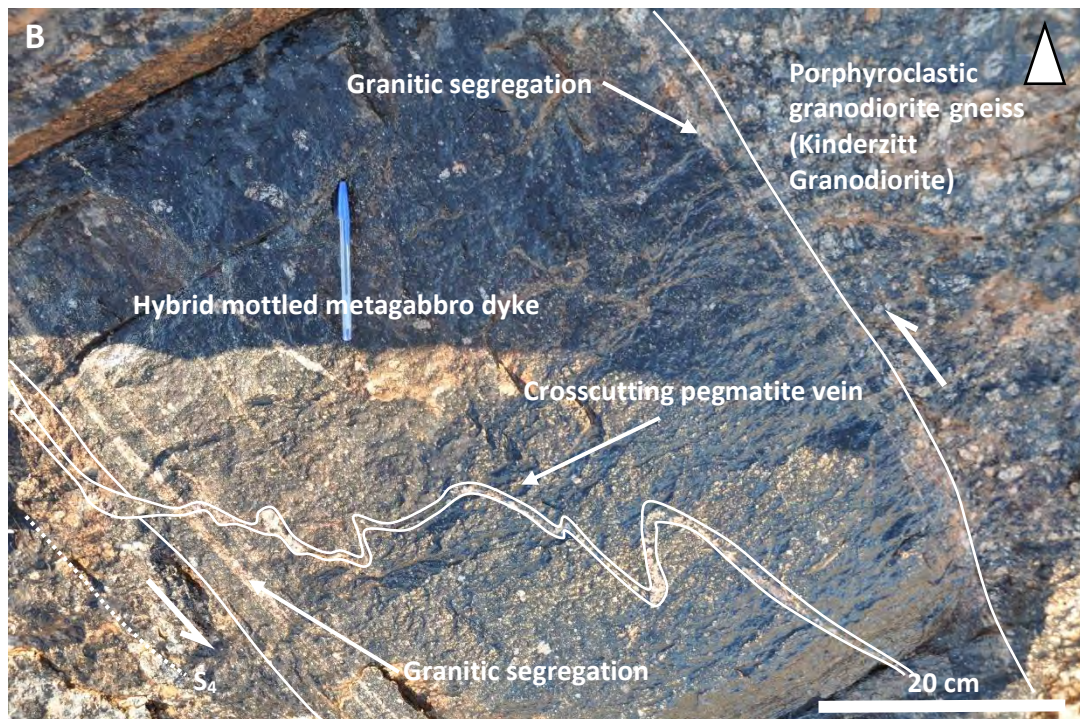


Figure 28: **A** - Example of a viz. HMG dyke which clearly syn-tectonically utilises the S_4 foliation. The dyke intrudes along a mylonite zone within porphyroclastic granodiorite gneiss of the Kinderzitt Granodiorite. Granitic segregations can be seen along its contact margins. **B** - Example of a viz. HMG dyke which clearly syn-tectonically utilises the S_4 foliation. A small syn- D_4 pegmatite vein can be seen to crosscut it and to indicate sinistral shear sense. "Floating" feldspar phenocrysts can be seen towards the interior of the dyke and granitic segregations can be seen along its contact margins.

4.3.4 Tectonic rocks of the MRPSZ and associated leucogranite and pegmatite intrusions

4.3.4.1 *Mylonite, phyllonite, cataclasite and psuedotachylite*

Protomylonite to ultramylonite, and minor phyllonite, cataclasite and psuedotachylite, which are always found to be in association with each other and which adhere to the overall trend of the MRPSZ, are present within all the domains and within all lithological units occurring throughout the study area. The frequency, continuity, and pervasiveness of these tectonic rocks vary between domains and the primary lithologies which host them. Within the HMG (domains C1 – C4) these tectonic rocks are typically expressed as more discrete and discontinuous cm's – m's wide high strain zones with sharp contacts against seemingly unaffected lower-strain country rocks, whereas within the Kinderzitt Granodiorite, Arus Gneiss agmatite and associated rocks (domains A, B and D), especially near their contacts with the HMG, they are typically expressed as 10's – 100 m's wide and km's long graded high strain zones which anastomose through and transect the entire study area. Syn-tectonic leucogranites are almost exclusively associated with discrete mylonites within domains C1 - C4 (i.e., the HMG).

In all cases these rocks are predominantly associated with progressive grain size reduction and the development of cohesive fine-grained rock matrix, inequigranular ovoid mantle-and-core porphyroclasts predominantly of feldspar, dynamic recrystallization of quartz and feldspar in pressure shadows of porphyroclasts or intrafolially as quartz-ribbons and feldspar bands, and S-S' shear fabrics. Similarly, cataclastic rock flower, phyllonite and subordinate psuedotachylite are in all cases associated with an increase in mica-content (*viz.* retrograde chlorite and muscovite), syn-tectonic streaky green amphibole (hornblende?) (e.g., Kartun, 1979; Toogood, 1976), and progressive pink-green (retrograde) discolouration due to alteration (e.g., figures 31A – 31B, 32, 33, 35 and 44). These cataclastic varieties are very rare within the study area and are typically restricted to the highest strain core zones of prominent ultramylonite zones. Intrafolial pseudotachylite is mostly encountered in domain B.

Kartun (1979), Toogood (1976) and Cisneros-Lazaro et al. (2019) collectively showed that the abundances of retrograde chlorite and muscovite and recrystallized mermykite and perthite within these rocks increase with increasing strain, and that it is likely contemporaneous. The overwhelming lack of brittle behaviour of feldspar porphyroclasts and syn-tectonic incohesive fabrics throughout the study area, and the fact that retrograde mineral assemblages are spatially correlated with areas in mylonite which exhibit the highest strain, all suggest these cataclastic fabrics and retrogression may be related to strain intensity and strain rate variations (e.g., Diener et al., 2016; Toogood, 1976). There are also many examples of ductile folded retrogressed fabrics and retrogressed fabrics intruded by pegmatite (e.g., figures 35, 40 and 41). Therefore, within the study area all indications are that the

bulk of these tectonic rocks formed at elevated temperatures, likely at $>450^{\circ}\text{C}$ (i.e., at least ductile-dominant regime; amphibolite facies), and that cataclastic processes and retrogression are temporally and spatially associated. Typical high strain D_4 structural fabrics which are locally encountered in the MRPSZ-system and in the study area surrounds, are presented in figures 29 – 44. Figures 29– 44 may serve as a baseline for referencing the general kinematics of the MRPSZ within the study area.

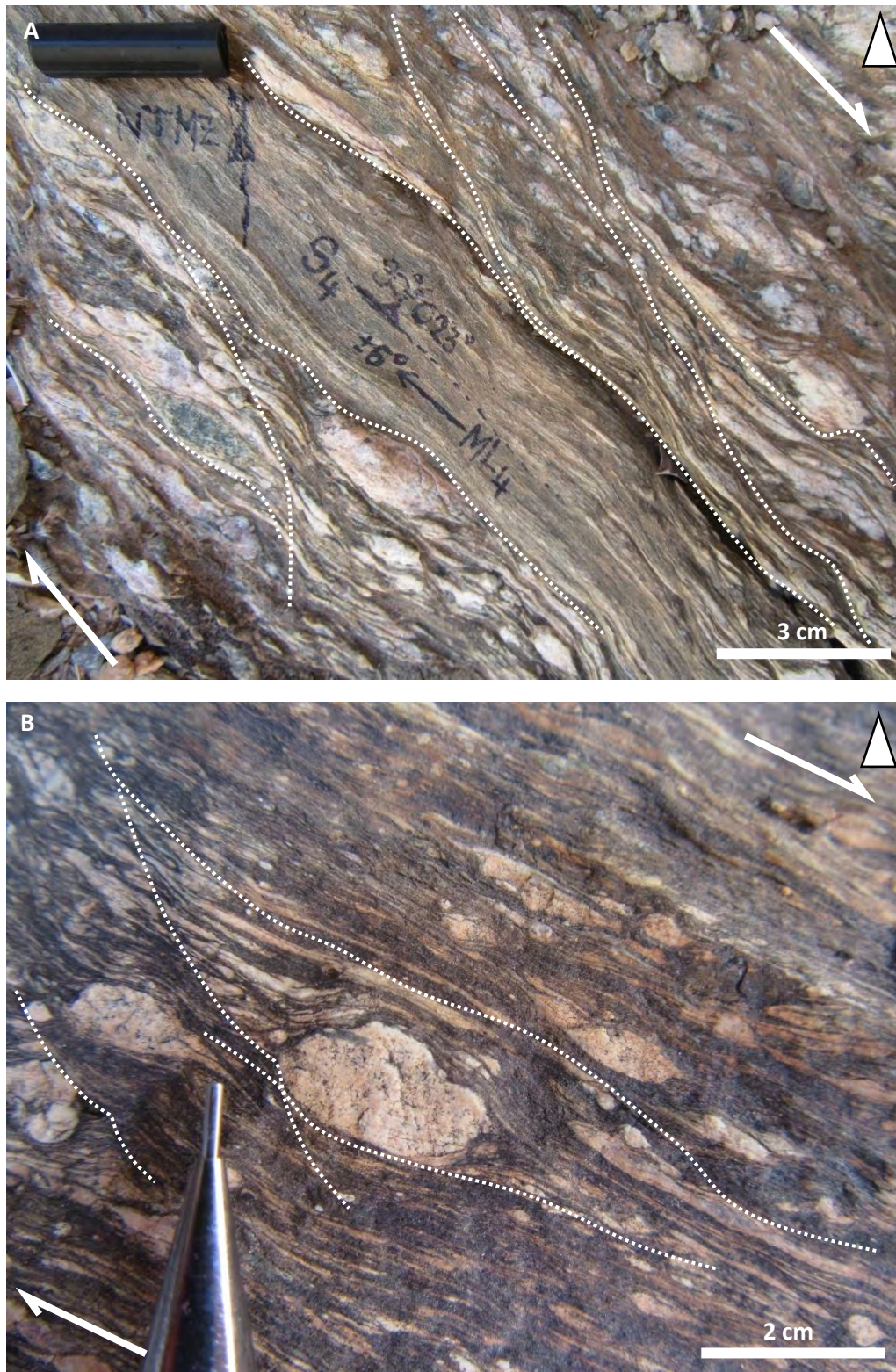


Figure 29: **A** – Mylonite with a core of fine-grained ultramylonite in domain B. A dextral shear sense is indicated by the S-C-C' shear fabric and feldspar porphyroclasts. **B** - A mylonite with dextral shear sense indicated by S-C-C' fabric and feldspar porphyroclasts in domain C1. Recrystallised feldspar and quartz are visible in pressure shadows of feldspar porphyroclasts and within intrafolial bands.



Figure 30: **A** – Northwest facing view of steeply dipping massive and cohesive ultramylonite after leucogranite dykes in domain C1. **B** – Northwest facing view of steeply dipping banded ultramylonite in domain D.



Figure 31: **A** – Retrogressed cataclastic rock-flower bound by banded quartzo-feldspathic mylonites in domain C1. The retrogressed portions are diagnostically green in colour due to increased chlorite content relative to the immediate surrounding quartzo-feldspathic mylonites. **B** – Northwest facing view of retrogressed phyllonite in domain C1. The retrogressed phyllonite is bound by mylonite along both contacts.



Legend

1 – Partially retrogressed S_4 ultramylonite.

2 – Zone of initial pseudotachylite formation and maximum grain size reduction. This zone likely represents the primary dislocation plane within the fracture. It is accompanied by *viz.* chlorite alteration which may indicate elevated H_2O incursion into these areas.

3 – Zone of pseudotachylite formation associated with increased breccia clast sizes and distal pseudotachylite injection.

The pseudotachylite is the glassy and very fine-grained material that formed within the principal slip zone. Its spatial association with the highest strain portions within mylonite zones indicates that it possibly formed because of momentarily increased local strain rates (e.g., during a seismic slip event).

Figure 32: A polished slab of pseudotachylite breccia which occurs sporadically throughout domain B, especially in mylonite and ultramylonite near the contacts of the HMG.

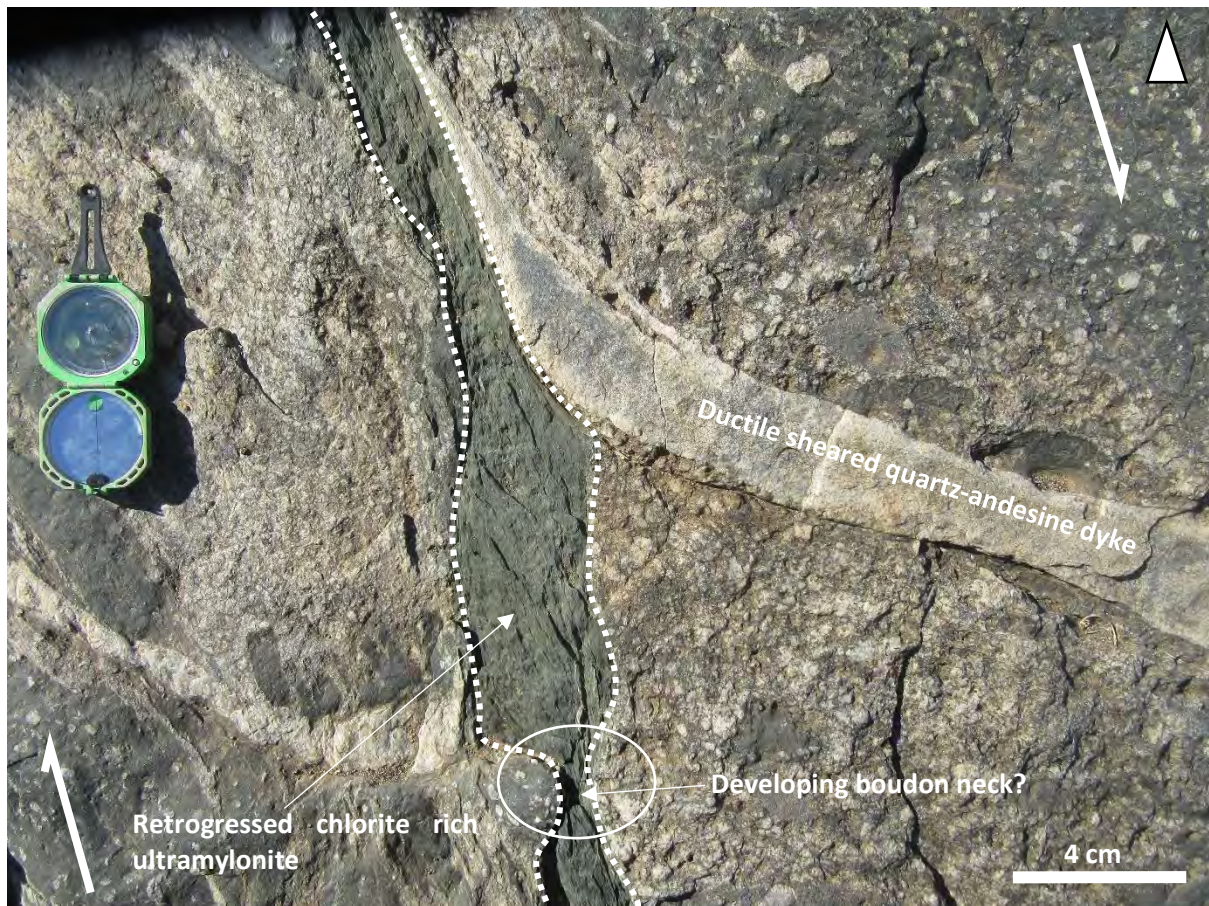


Figure 33: Retrogressed chlorite rich ultramylonite in HMG. The country rocks are clearly ductile sheared relative to the retrogressed ultramylonite.



Figure 34: Pegmatite intruded and transposed (mylonitised) into S_4 within a high-strain ductile zone within domain A. These feldspar porphyroclasts and quartz ribbons represent relict portions of highly transposed earlier syn-tectonic pegmatite within S_4 .

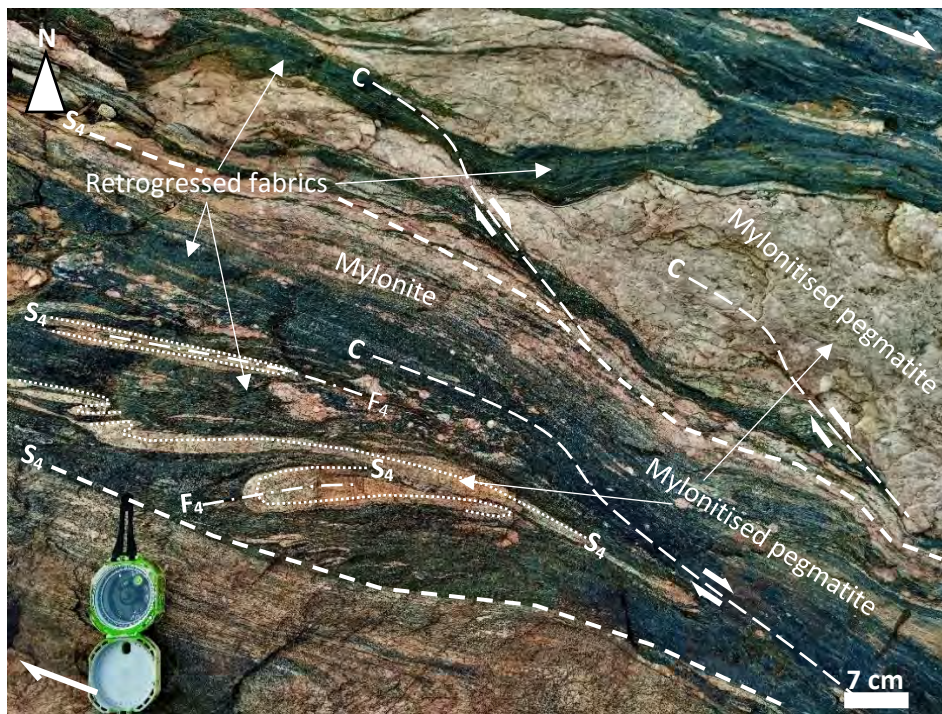


Figure 35: Syn-tectonic pegmatite intruded and transposed (mylonitised) into S_4 within a high strain ductile zone within domain A. Asymmetric (right lateral) intrafolial (shear) folding of felsic S_4 mylonite and/or syn-tectonic pegmatite may define an intrafolial and isoclinal F_4 , although highly reworked and transposed. Retrogressed fabrics (with chlorite and epidote) are clearly ductile and associated with the higher strain zones. Larger pegmatite lithons are boudinaged by synthetic C-shears and wrapped tightly within S_4 mylonite.



Figure 36: Example of a dextral feldspar mantle-and-core porphyroblast within S_4 ultramylonite within domain A. The feldspar porphyroblast core is unfractured and is rimmed by recrystallized feldspar and quartz, indicating amphibolite facies P-T conditions during ductile > brittle-ductile shearing. The feldspar porphyroblast is a relic of a highly transposed syn-tectonic pegmatite which intruded parallel to S_4 slightly earlier during shear zone development.



Figure 37: Multiple generations of syn-tectonic pegmatite intruded into variably reworked S_4 fabrics in a ductile high strain zone within domain A. The older intrafolial syn-tectonic pegmatites and mylonite are transposed into a younger S_4 and are again cross-cut by a younger intrafolial syn-tectonic pegmatite. This outcrop illustrates the process of continual reworking and redevelopment of D_4 fabrics within ductile D_4 high strain zones.



Figure 38: A D_2 banded amphibolite gneiss showing S_2 which is crenulated by S_4 within the study area surrounds (MRPSZ-system). This S_2/S_4 crenulation therefore shows F_4 as occurring outside of the high strain (mylonitic) zones also. The general NE-SW strike of the S_2 fabric is a result of its right lateral ductile drag into the MRPSZ at a considerable distance from its core.

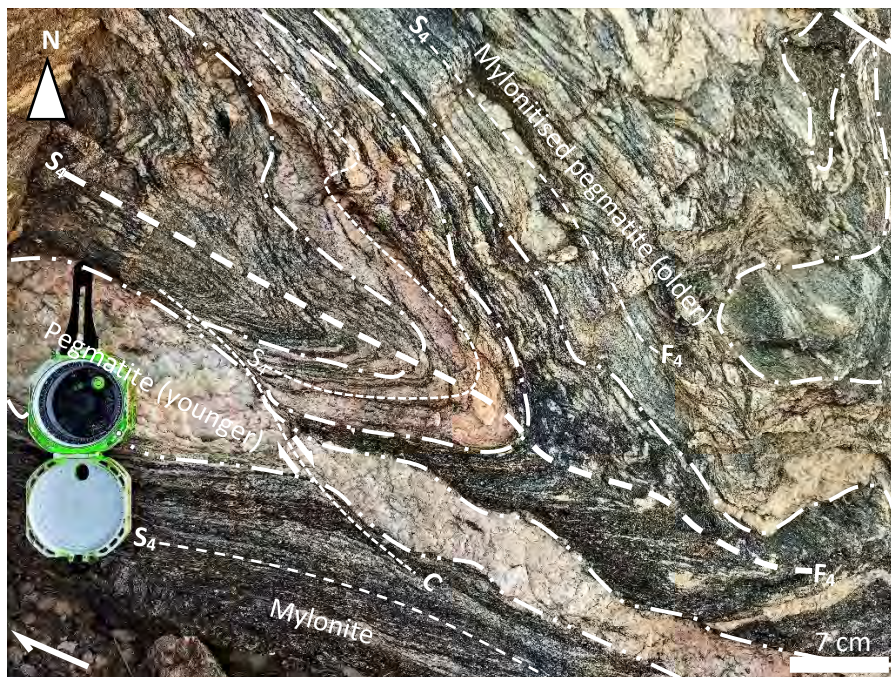


Figure 39: Multiple generations of syn-tectonic pegmatite intruded into variably reworked S_4 fabrics in a high strain zone within domain A. The older intrafolial S_4 syn-tectonic pegmatites and mylonite are transposed into a younger S_4 and are again cross-cut by a younger intrafolial syn-tectonic pegmatite. This outcrop illustrates the process of continual reworking and redevelopment of D_4 fabrics within ductile D_4 high strain zones. It also shows that F_4 may be defined by reworked and transposed S_4 mylonite.



Figure 40: Banded (D_2) leuco-gneiss, outside of a D_4 (mylonitic) high strain zone within the study area surrounds (MRPSZ-system), showing similar F_4 folds defined by the S_2/S_4 crenulation within the study area (MRPSZ-system). The syn-tectonic pegmatite is clearly seen to intrude parallel to S_4 and the F_4 axial plane and is associated with non-coaxial strain localization. The country rocks adjacent to the pegmatite also exhibit ductile drag of S_2 with contemporaneous synthetic C-shear band development.



Figure 41: Two generations of syn-tectonic pegmatite intruded into variably reworked S_4 fabrics in a high strain zone within domain A. S_4 is defined as the alignment of micas within the younger (coarser grained) pegmatite. Relicts of an older pegmatite can be seen as transposed and reworked mylonitic S_4 and F_4 fabrics which still retain feldspar porphyroclasts with rims of recrystallized quartz and feldspar. The younger intrafolial S_4 pegmatite is clearly seen to concordantly intrude older and completely mylonitized intrafolial pegmatite and S_4/F_4 fabrics which now exhibit asymmetry relative to shearing.

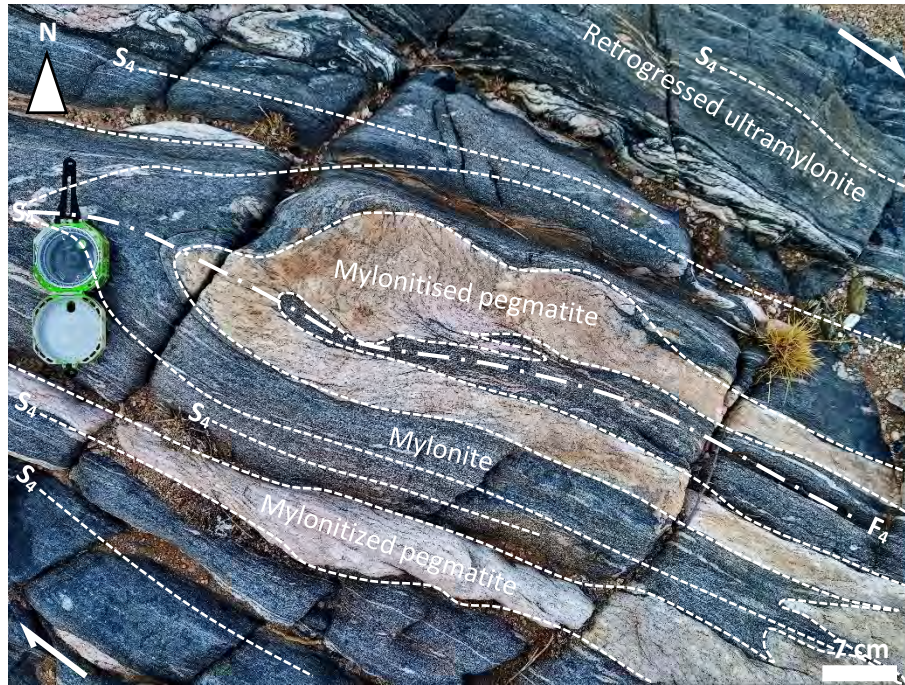


Figure 42: Intrafolially transposed mylonite and syn-tectonic pegmatite within the study area surrounds (MRPSZ-system). The earlier D_4 fabrics have been completely transposed into a younger S_4 and F_4 fabric. The mylonitised syn-tectonic pegmatite and mylonites define an isoclinal intrafolial F_4 fold which is again in parallelism with the younger S_4 fabric, thus illustrating the continual reworking, redevelopment, and transposition of D_4 fabrics within such ductile high strain zones.



Figure 43: Intrafolial isoclinal F_4 , defined by similar folding of earlier S_4 felsic mylonite in a ductile high strain zone within domain A. L_4 , on S_4 , can clearly be seen to be sub-parallel to the plunge and dip of the F_4 hinge and axial plane. This implies that this L_4 consists of a transposed fabric and that an earlier L_4 and S_4 has been completely reworked, although now in parallelism with this younger L_4 fabric.



Figure 44: Ductile folded retrogressed S₄ fabrics comprised of green micas (chlorite?), epidote and pink alkali feldspars, and associated earlier intrafolial pseudotachylite breccia of ultramylonite, occurring within the study area surrounds (MRPSZ-system). Such outcrops, although very rare, support bulk shearing under ductile dominant conditions, with retrogression in the core zone of the MRPSZ most likely representing local manifestations of high pH₂O within areas of high strain and high strain rates.

4.3.4.2 *Syn-tectonic granitic melts associated with the MRPSZ*

4.3.4.2.1 Leucogranite (quartz-andesine) intrusions and associated scheelite bearing quartz-tourmaline veins

Numerous syn-tectonic granitic sills, dykes, and plugs, comprised of medium-grained equigranular andesine feldspar, quartz, and muscovite and accessory biotite, epidote, and chlorite (e.g., Von Backström, 1976), occur predominantly within the HMG in domains C1 – C4. These rocks are visually identified as equigranular leucogranite and to a minor extent aplite. These intrusions are inferred to have crystallised at eutectic conditions as andesine shows poikilitic intergrowth with quartz, with the overall modal quartz % being estimated at 20 – 35 % (Von Backström, 1976). They have been informally termed *quartz-andesine intrusives* by Von Backström (1976) and this term, and the term “leucogranite”, is adopted interchangeably in this study when referring to these rocks. They are only rarely encountered within domains A, B and D. Within domains C3 and C4 they occur predominantly as irregular plugs and shallower dipping sills-and-dykes with a weakly defined L-S fabric. Within domains C1 and C2 they occur predominantly as partially mylonitised, steeper dipping, and foliation parallel dykes accompanied by a strong L-S fabric. In domains C3 and C4 a pegmatitic texture may be observed in small portions of the intrusions (e.g., figure 49). Overall, the observed textures and composition of the leucogranite intrusives are often very similar to the granitic segregations which occur along the interior margins of the *viz.* HMG dykes outside of the study area. Within the study area the leucogranite dykes are clearly crosscut by pegmatites of Swanson Tantalum Deposit and are therefore older in age (e.g., figure 47).

The leucogranites are easily identified by their cream-pink colouration, positive weathering characteristics, and overall fine- to medium-grained equigranular texture, and in the case of domains C1 and C2 also by the tombstone-like ridges which they exhibit (e.g., figure 48A). The overall surface expression, volume and irregularity of individual intrusions increases with proximity towards the TVC proper, and their overall parallelism, aspect ratio and continuity increase with proximity away from the TVC proper (e.g., figure 18). These intrusions rarely continue to occur outside of the study area but are also encountered within the TVC proper.

In many places these leucogranite dykes can be seen to host irregular and gradational quartz segregations (e.g., figure 49). It is observed that these segregations transition into zoned *viz.* quartz-feldspar-tourmaline biotite-amphibole-scheelite veins where these dykes thin out to cm-mm scale widths (e.g., figure 49A and 50). In some cases, these veins appear to be associated with *viz.* streaky amphibole (tremolite?) and tourmaline on foliation surfaces and phyllonitisation of host rock. These veins were variably worked in the past for scheelite, where scheelite can be identified as mm’s scale dark brown-maroon crystals occurring as aggregates in the cores of veins and/or as disseminated

crystals within the phyllonitic country rock (e.g., figure 50). However, the frequency of the various veins which occur within the study area, whether barren or mineralised with respect to scheelite, is very low when compared to that of the leucogranite dykes. These veins are clearly seen to be crosscut by locally occurring pegmatites of the ORPB and are therefore older.



Figure 45: NW facing view of interconnected leucogranite dykes intruding HMG. The dykes clearly utilise the S_4 foliation within the study area.



Figure 46: Partially mylonitised leucogranite dyke intruding HMG and utilising the S_4 foliation within the study area.



Figure 47: **A** and **B** – Crosscutting relationships showing that the locally occurring pegmatites of the ORPB crosscut the leucogranite dykes.

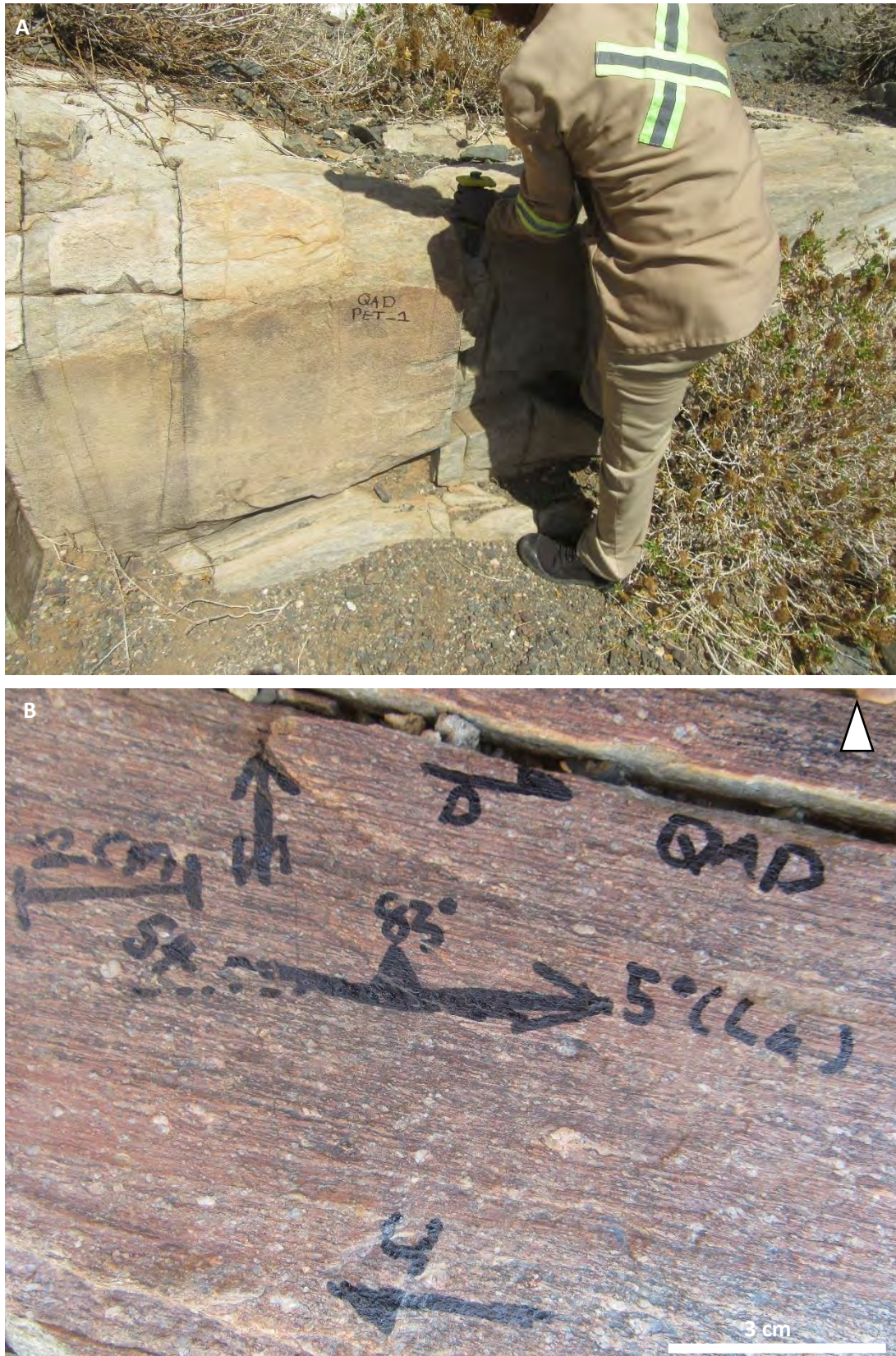


Figure 48: **A** – Medium-grained and equigranular leucogranite dyke slab which is typical in domains C1 and C2. **B** – Mylonitised leucogranite dyke with a prominent L-S fabric.

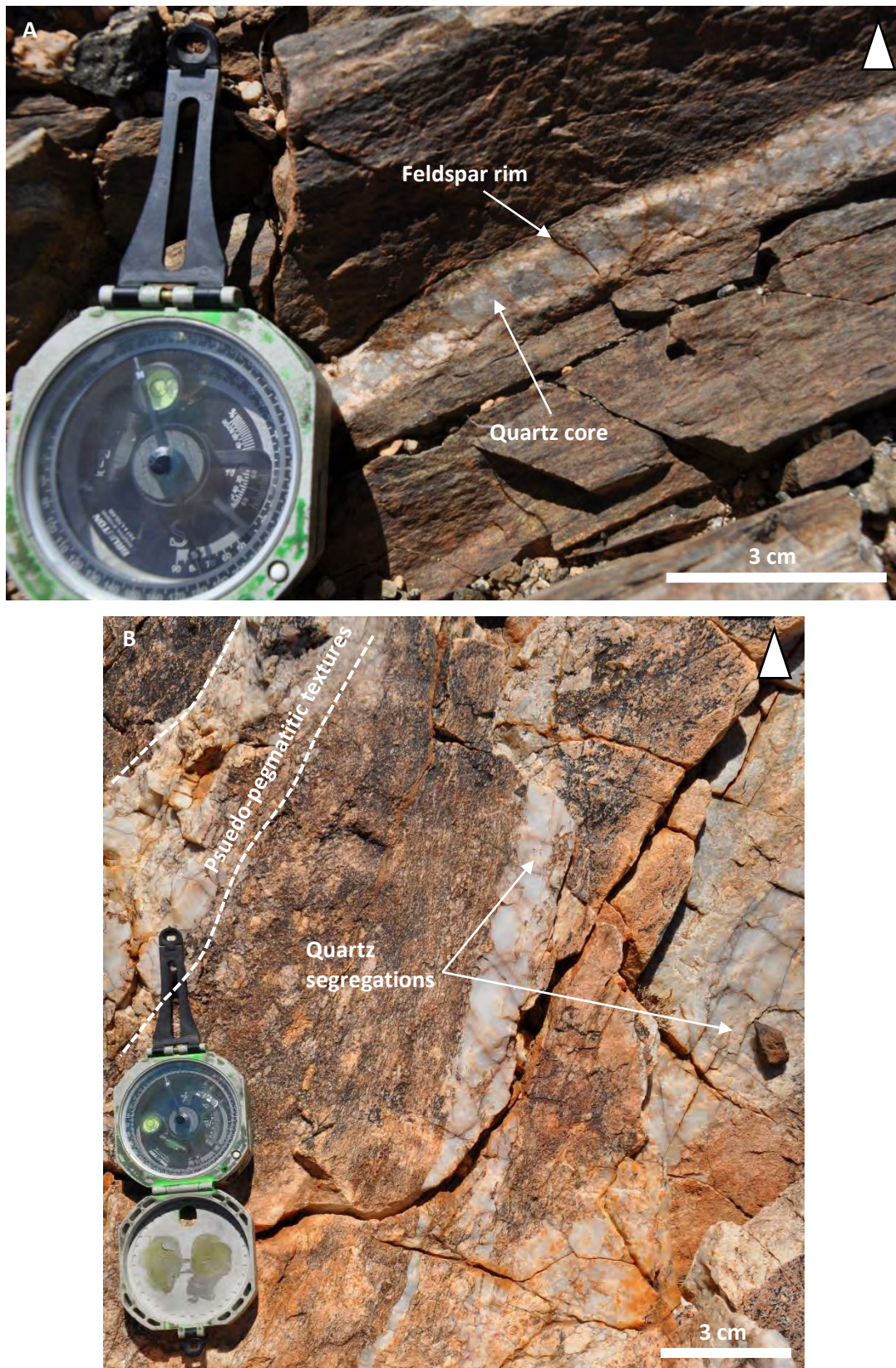


Figure 49: **A** – A thin zoned vein with feldspar rims and a quartz core associated with leucogranite dykes. **B** – Irregular and graded quartz segregations with a leucogranite dyke as well as a zone of pseudo-pegmatitic texture in domain C1.



Figure 50: **A – C** – Syn-tectonic phyllonite hosted quartz-feldspar-biotite scheelite veins clearly utilising the S_4 foliation. The scheelite crystals are clearly seen to occur as both aggregates and disseminated mineralisation relative to the host-vein. The native sulphur seems to indicate the presence of weathered sulphides, although sulphide minerals could not be observed in hand specimen.

4.3.4.2.2 Pegmatites of the Swanson Tantalum Deposit

A predominantly discordant sill-and-dyke swarm, comprising relatively shallow dipping syn-tectonic mineralised pegmatites intruding into HMG (domains C1 - C4), collectively define the Swanson Tantalum Deposit within the study area. These pegmatites are the focus of ORP's current mineral exploration activities. The main mineralogical constituents of these pegmatites comprise *viz.* massive white to grey quartz, crystalline perthitic feldspar, lithium mica, and sugary albite, with accessory spodumene, beryl, apatite, garnet, biotite, fluorite, bismuth-bismuthinite (?), microlite and tantalite (Young et al, 1981; this study; e.g., figures 14, 18, 51 – 57 and 58A). The accessory minerals are numerous in their occurrence but are not equally abundant throughout all pegmatites. These pegmatites can with certainty be attributed to the LCT-type family of pegmatites due to the economically significant quantities of Ta and Li bearing mineral phases present within in them (this study; Young et al, 1981). The economic aspects of these pegmatites and their respective clusters will be further discussed in Chapter 5. Only their general lithological and field characteristics will be discussed here.

A diagnostic feature of these pegmatites is the abundance of fine to medium-grained homogenous masses and bladed and semi-radiating clusters (cleavelandite var.) of sugary albite and “quartz-blebs” with gradational contacts (relative to well defined blocky feldspars with graphic textures), as well as their general lack of definitive internal zonation (e.g., figures 54 - 56). Additionally, a very low abundance of beryl and tourmaline is also conspicuous. However, partial layering defined by sugary albite, quartz segregations and spodumene – lepidolite concentrations are common within the economically most significant ones, and rarely a semblance of a quartz core can be observed (e.g., the E3 pegmatite in figure 56A). Often a faint unidirectional crystallization texture of spodumene, which is perpendicular to the intrusive contacts, can also be observed (e.g., figures 55A and 58A).

Although speculative without petrographic study, it appears as if finer-grained tantalum mineral concentrations occur predominantly in areas with abundant sugary-albite, and coarser grained tantalum mineral concentrations occur predominantly in areas with abundant spodumene, lepidolite and/or perthitic feldspar (e.g., Young et al., 1981). Young et al (1981) postulated that lithium mica, sugary albite, spodumene and most of the tantalum minerals formed relatively late in the crystallization history of the pegmatites. The pegmatites have been shown to contain between 200 – 1000 ppm Ta₂O₅, and where spodumene concentrations are high (> 10 – 30 %), between 0.20 – 1.30 % Li₂O (this study; Young et al., 1981). The Nb₂O₅ contents rarely exceed 100 ppm.

The field descriptions of the various accessory mineral constituents occurring within these pegmatites is given in table 5.

Table 5: Field descriptions of the various accessory mineral constituents of the LCT-type pegmatites occurring within the study area.

Mineral	Field description
Apatite	Blue to green fine-grained prismatic crystals
Beryl	Pale green coarse to fine-grained subhedral crystals. Rare.
Lithium mica	Grey to greenish grey coarse plates (zinnwaldite) and/or pink to purple (lepidolite), often occurring as semi-radiating groups of elongated books. Often in association with spodumene.
Fluorite	Very fine-grained deep purple euhedral crystals
Spodumene	Greyish white to pink-purple (kunzite var.) to blue colour coarse-grained prismatic laths, splintery, often exhibiting unidirectional crystallization texture. The laths are often kinked and bent. Often in association with lepidolite.
Tantalite	Commonly as metallic grey-black very fine-grained needle shaped crystals ≤ 1 mm long, to crystals measuring 2 – 5 mm in length and 1 mm in width. More rarely as metallic coarser bladed and prismatic crystals 1 – 3 cm in length and
Microlite	Fine to medium-grained, sub-metallic crystals.
Garnet	Generally fine-grained to locally medium-grained, honey brown to orange-maroon euhedral crystals (spessartine var.).
Biotite	Very fine-grained brownish-black flakes occurring in small books up to a few cm's across.
Bismuth-Bismuthinite (?)	Metallic sooty grey to black, soft, anhedral. Sometimes associated with copper staining and free sulphur.

The pegmatites typically dip between 15 – 20° towards the NE, strike roughly NE-SW, and range in thickness from a few cm's to a maximum of about 12 m, with the average thicknesses seemingly ranging between 1 – 4 m. The pegmatites are laterally continuous along dip and strike and appear to swell within its central portions and thin towards its furthest peripheries. They are often seen to bifurcate and reconnect, sometimes resulting in a country rock “middling”. However, laterally extensive pegmatites seem to be connected rather by rare moderate to steeply dipping and less extensive apophyses, although these are not commonly observed (e.g., figure 52A).

The pegmatites do not intrude across the tectonic contacts between the HMG (domains C1 – C4) and the enveloping rocks of domains A, B and C. Indeed, they are constrained by it. They appear to be truncated and variably affected by the mylonite zones adjacent to the major tectonic contacts possibly indicating that mylonitic fabrics within domains A, B and D has endured slightly past the time of pegmatite emplacement within domains C1 – C4. This hypothesis is further substantiated by the presence of gentle open folding of these pegmatites, kinking and dragging of spodumene laths, and apparent thrusting or shearing along some of the pegmatite contacts, even though they are predominantly discordant to the mylonitic foliation developed within the HMG.

There are also several steeply dipping, concordant, and partially mylonitised pegmatites emplaced within the mylonitic foliations of rocks outside of the HMG (domains A, B and D), however these have not been considered of significant economic importance in the past (e.g., Young et al., 1981) and are neither at present (e.g., figure 58B). These pegmatites are mineralogically distinct from those within

domains C1 – C4, in that they are chiefly comprised of *viz.* blocky feldspar with distinct graphic texture, blocky quartz, muscovite and garnet. No exotic minerals, specifically those containing tantalum and lithium, are observed within them. Their thicknesses are also usually less than 1 m, and they are laterally concordant within the mylonitic foliation.

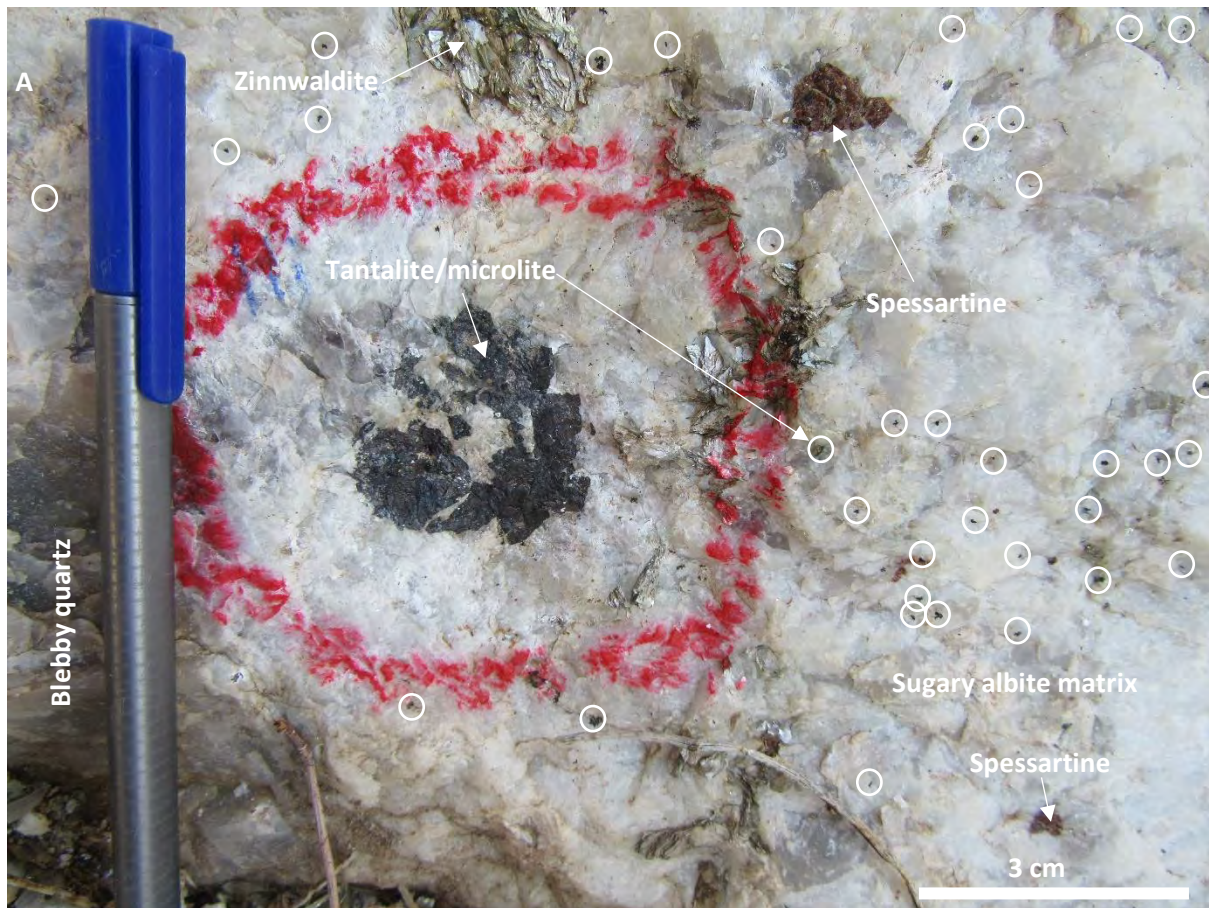


Figure 51: Closeup of coarse-grained and fine-grained tantalum mineralisation in a matrix of sugary albite with accessory zinnwaldite and spessartine garnet.



Figure 52: **A** - West facing view of interconnected and bifurcating pegmatites showing the “plumbing system” by which pegmatite melts were emplaced within the HMG. **B** – South facing view of typical outcrop of pegmatite of shallow dipping pegmatite within the study area.



Figure 53: A – Southwest facing view of a cluster of shallowly dipping pegmatites within HMG showing the consistency that they retain with their spacing and lateral continuity. B – pegmatite crosscutting the prevalent mylonitic foliation and associated leucogranite dyke at a high angle.

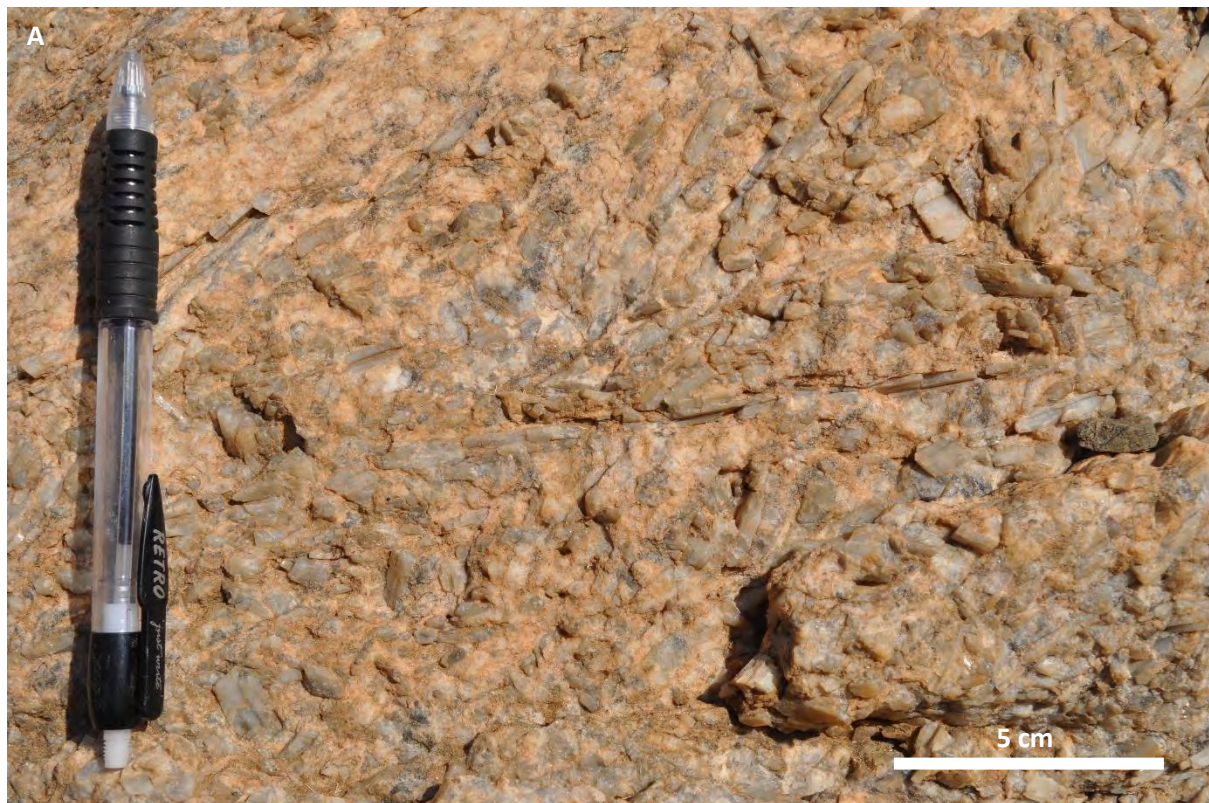


Figure 54: **A** – High concentrations of prismatic spodumene laths within a matrix of sugary albite. **B** – clusters of fine-grained lepidolite within a matrix of sugary albite and blebby quartz.

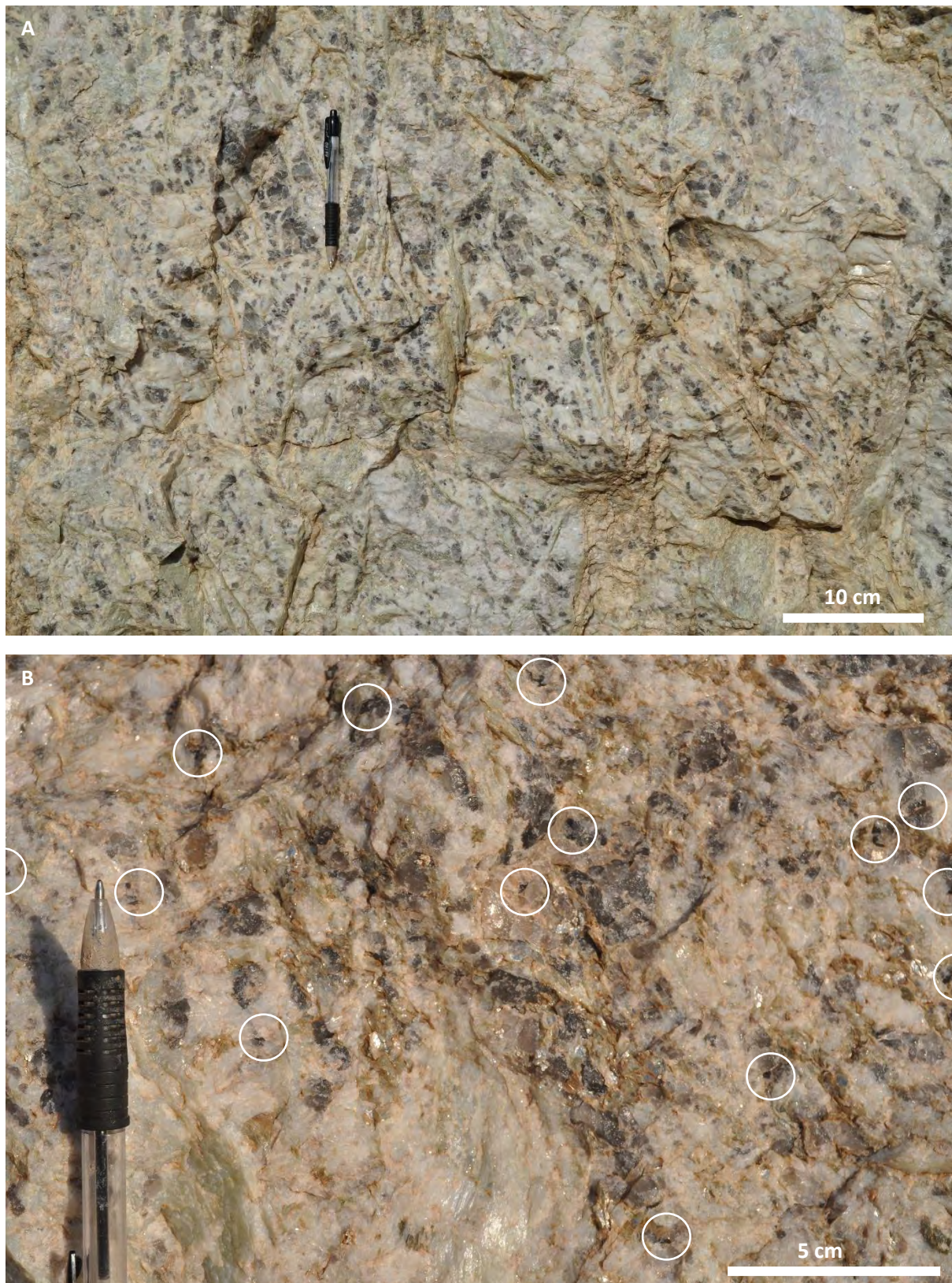


Figure 55: **A** – Sugary albite dominated pegmatite with blebby quartz and elongated zinnwaldite books. **B** - Sugary albite (cleavelandite var.) dominated pegmatite with blebby quartz and elongated zinnwaldite books. Disseminated fine-grained tantalite and microlite crystals are clearly visible.

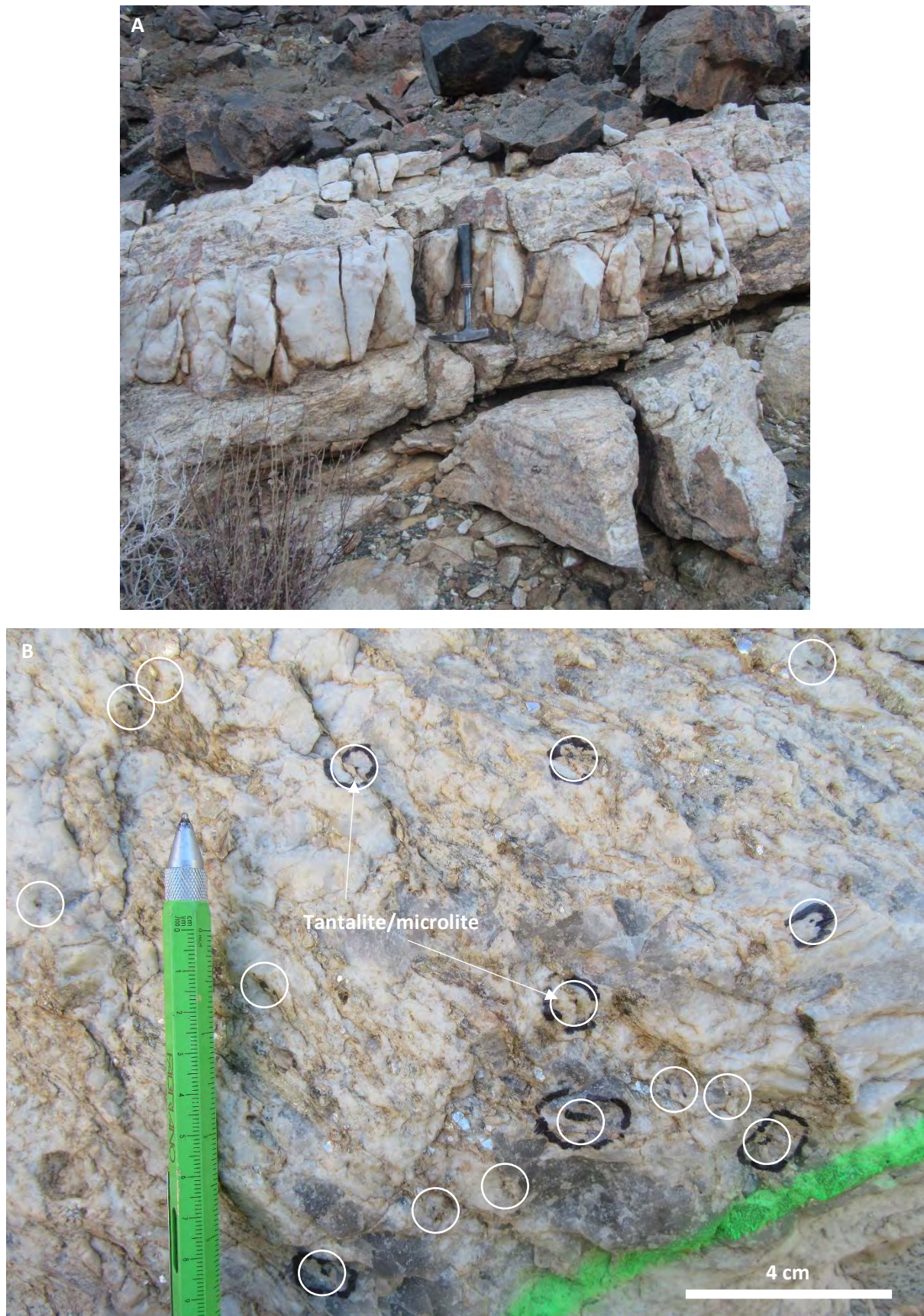


Figure 56: A – A clearly defined quartz-core surrounded by sugary albite in the E3 pegmatite. This is the exception and not the rule. B – Sugary albite dominated pegmatite with blebby quartz and minor coarse-grained zinnwaldite books. Disseminated tantalum mineralisation is clearly visible.

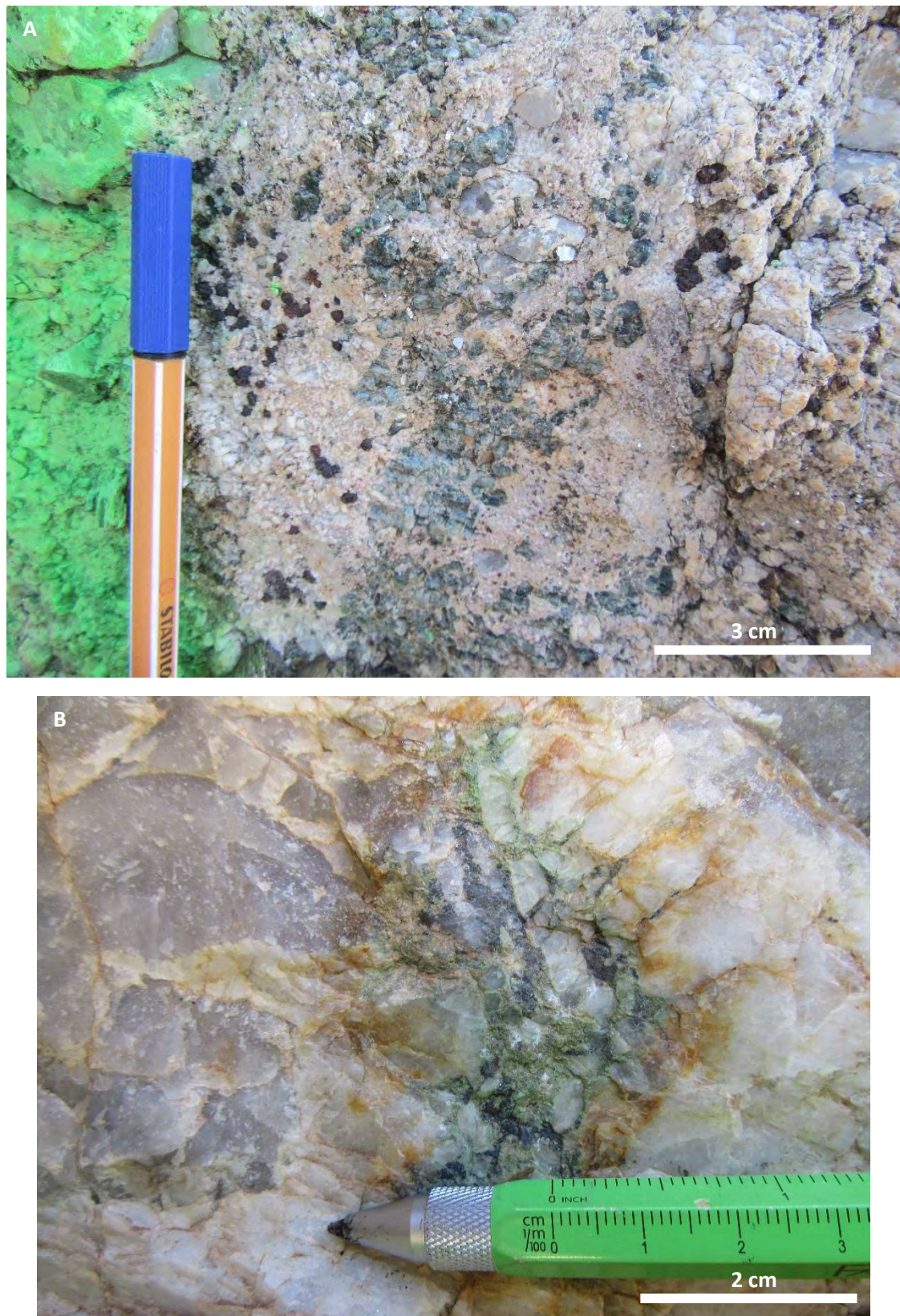


Figure 57: **A** - An unusually high concentration of apatite and spessartine garnet crystals within a viz. perthitic feldspar, sugary albite, and blebby quartz matrix. **B** – a small concentration of bismuth/bismuthinite (?) associated with minor copper staining and secondary native sulphide.

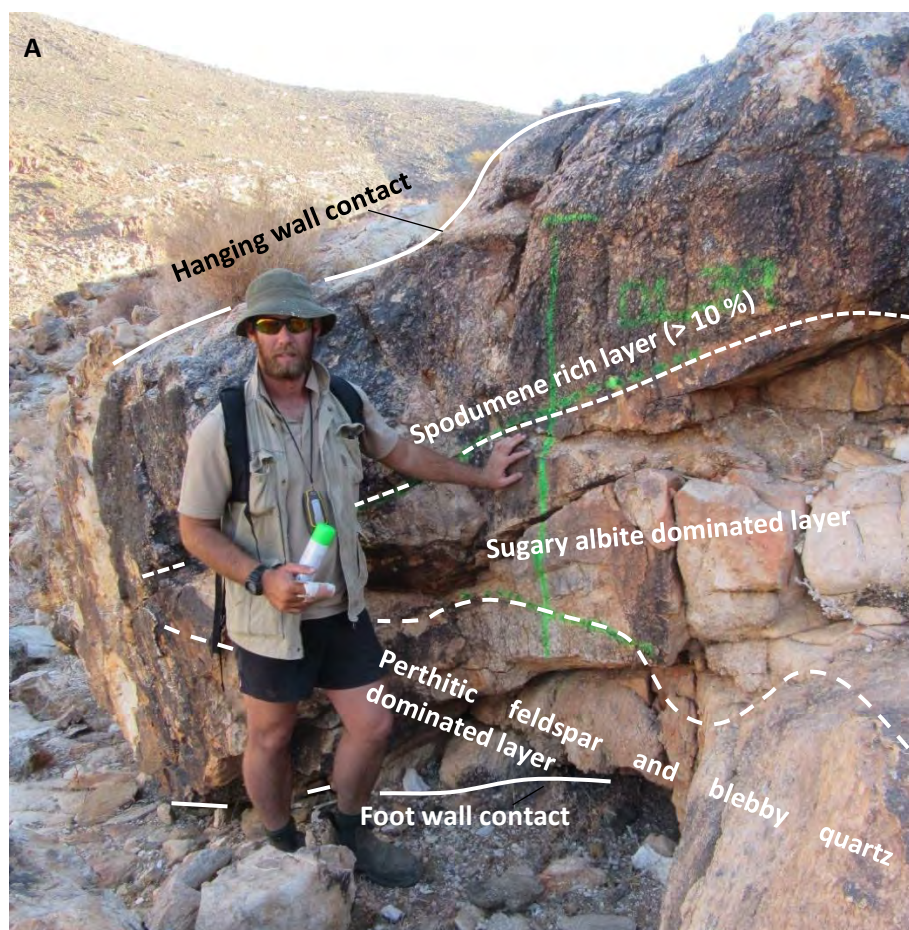


Figure 58: **A** – Conspicuous layering defined by an upper spodumene rich layer along the upper contact and a sugary albite dominated layer along the lower contact. This is the D1 pegmatite. **B** – A southeast facing view of a concordant and partially mylonitised pegmatite within domain A.

4.4 Structural fabrics

4.4.1 Mylonitic foliation (S_4), mineral stretching lineation on S_4 (L_4), and folding of S_4 and pegmatites (F_4)

S_4 within the study area is primarily defined by a dextral-dominant mylonitic foliation (e.g., figures 59 - 60). Whether discretely or pervasively developed, retrogressed or not, it conforms to the kinematics of the MRPSZ. It is also defined by relatively lower strain and possible preferentially orientated magmatic fabrics within the HMG (e.g., figure 60C; domains C1 – C4). In domains C1 – C4 the contacts of the leucogranite dykes are typically syn-tectonic to and sub-parallel to S_4 , and therefore cannot be separately distinguished (e.g., figures 59 and 60A, 60B and 60D). S_4 within domains A, B and D, is represented by 10's - 100 m's wide and km's long anastomosing mylonitic zones, whereas in domains C1 – C4 it is represented by numerous and more discrete m's wide and 100's m's long anastomosing mylonitic zones (as described in Chapter 4.3.4). In all domains these mylonite zones are separated by lower strain zones. S_4 , and so also the associated leucogranite dykes, become progressively disorganised with increasing proximity to the TVC proper (e.g., figures 18 and 64 and table 6). On S_4 , retrograde chlorite and muscovite is commonly associated with the highest strain, finest grained ultramylonites, and in some cases, such as in domain B, may be associated with psuedotachylite breccia in ultramylonite. Trails of recrystallised quartz-feldspar aggregates and of feldspar porphyroclasts are commonly visible on the surface of S_4 (i.e., L_4).

The sub-classification of specifically D_4 mylonitic foliations (S_4) and mineral stretching lineations (L_4) into “older” (e.g., L_{4a} , S_{4a}) and “younger” (e.g., S_{4b} , S_{4b}) generations, as relating to a progressively exhumed shear zone model proposed by Lambert (2013) and Macey et al. (2015, 2017), was not utilized in this study for reasons already mentioned in Chapter 2.5. In this study they are described as L_4 and S_4 only.

Pegmatite in domains C1 – C4 is clearly late syn-tectonic with respect to S_4 , since it can be seen to cross-cut S_4 at high angles, while pegmatite in domains A, B and D, is clearly associated with and sub-parallel to S_4 .

L_4 within the study area is primarily defined by a strongly developed quartz-feldspar mineral stretching lineation on S_4 . It is mostly observed on the contact surfaces of leucogranite dykes (e.g., figure 61B) within domains C1 – C4, and as stretched (rodded) quartz-feldspar-biotite aggregates on the surfaces of mylonitic and gneissic foliations in domains A, B and D. The orientation of L_4 is highly variable depending on the domain in question, however there is an overall trend towards the SE within the study area (e.g., figure 65; refer to table 6). There are cases where L_4 is accompanied by and/or defined

by syn-tectonic amphibole (tremolite?) on the contact surfaces of leucogranite dykes, however this is uncommon.

In the authors opinion previous workers have not sufficiently defined F_4 . For example, is F_4 defined by intrafolially folded S_4 , folded syn- S_4 pegmatites which are discordant to S_4 , or by folding of earlier fabrics (S_2/S_3) and/or of lithologies outside of D_4 high strain zones? Therefore, for the purpose of this study, F_4 is taken as representing intrafolial folding of S_4 , and folding of pegmatites (e.g., PCF₄; table 4) only. These are assumed to be of the same age but are separated accordingly. F_4 folding of S_4 is typically tight to isoclinal with a strongly developed axial planar fabric (also S_4), sometimes rootless, and are in all cases observed to plunge sub-parallel to L_4 , regardless of the domain in question (e.g., figure 62 and 63 - 65).

A summary of the various characteristics of S_4 , L_4 and F_4 as encountered within the study area is given in table 6 and figure 64. Figure 65 shows the variability of these structural fabrics across all the domains, thereby highlighting the complexity and heterogeneity of strain partitioning between domains.

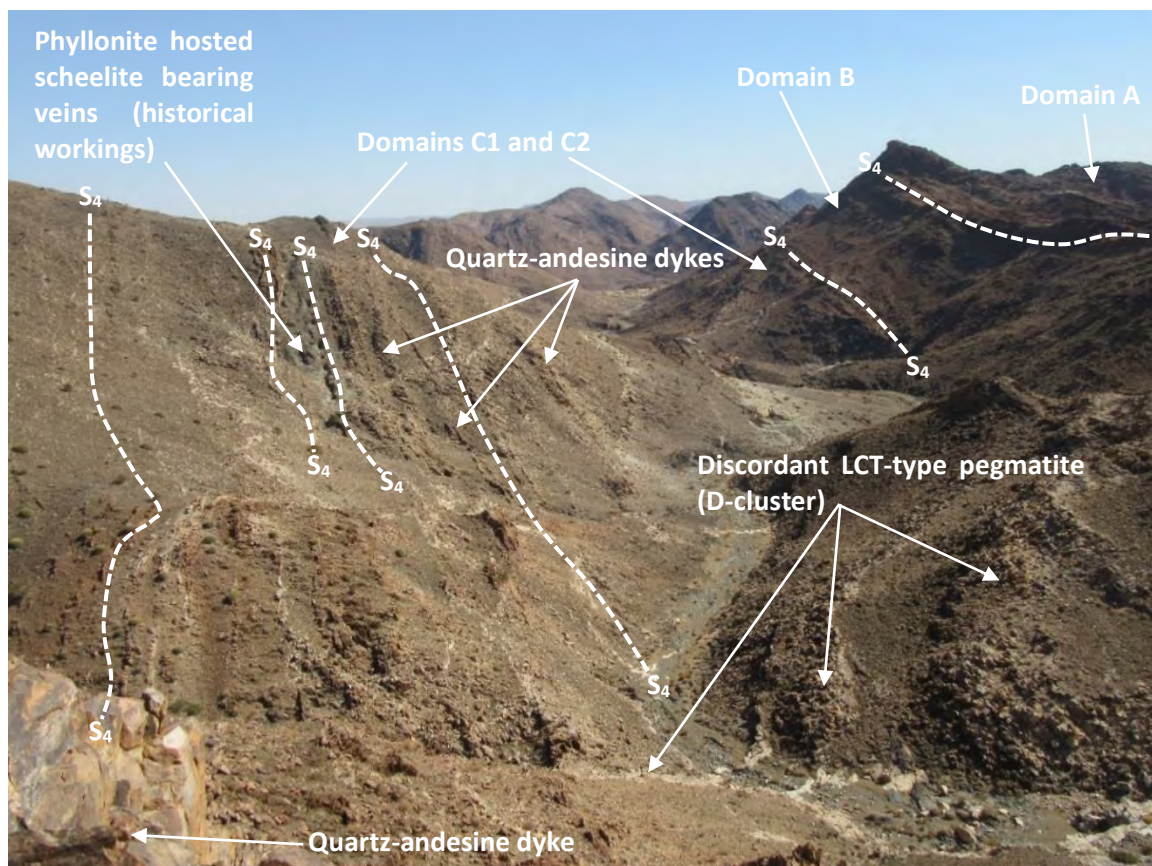


Figure 59: Looking NW within domains C1 and C2. The S_4 structural fabric and associated syn-tectonic leucogranite dykes can clearly be seen to conform to the overall structural trend of the study area. The discordant LCT-type pegmatites, which are still syn-tectonic, are also indicated. Phyllonite hosted quartz-feldspar-biotite-amphibole-scheelite veins are also shown to be sub-parallel to S_4 .

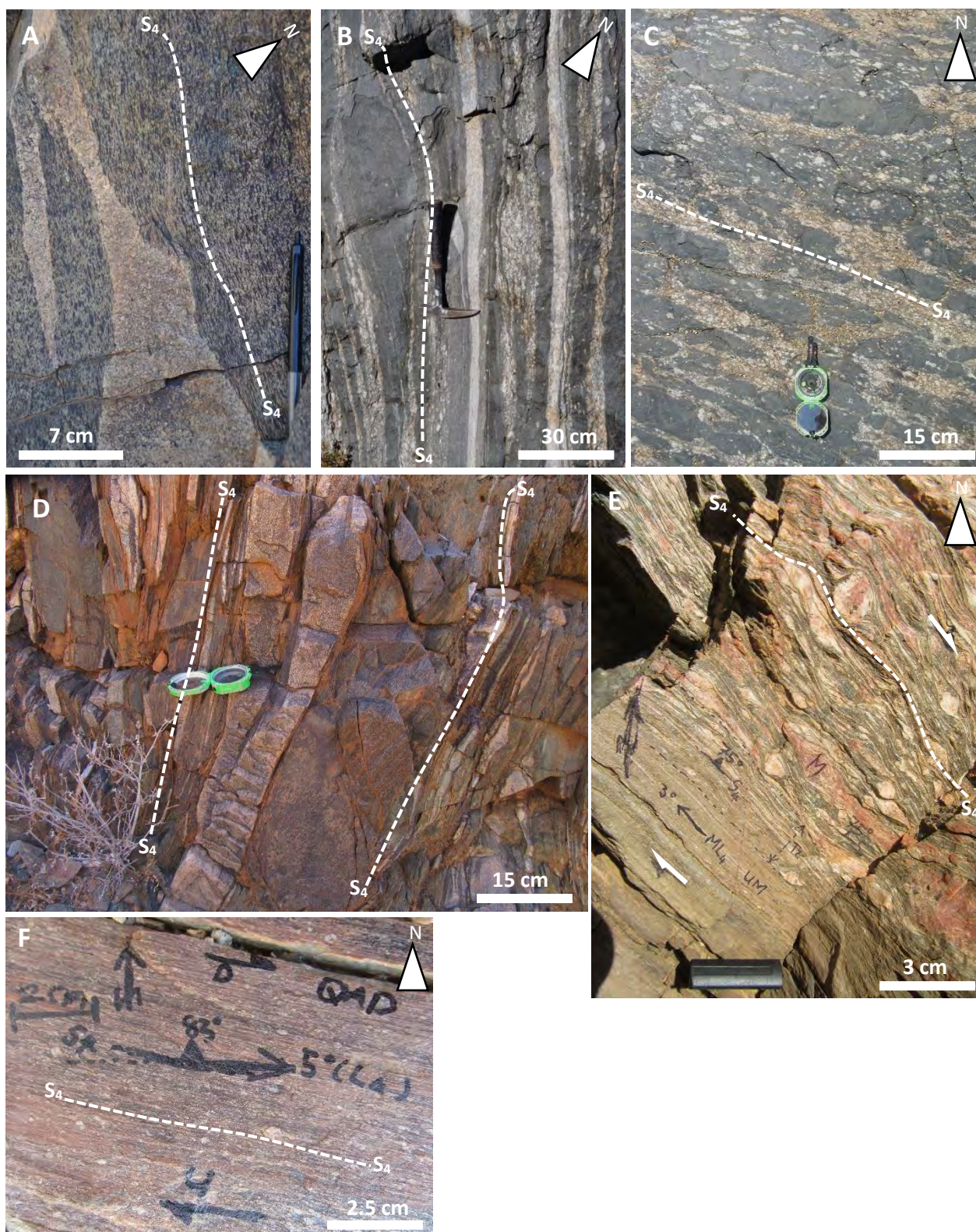


Figure 60: **A** – Looking NW onto HMG outcrop with a strongly developed S_4 and a syn-tectonic leucogranite dyke utilising this foliation in domain C1. **B** – HMG showing a strong conformism to S_4 , with younger syn-tectonic leucogranite dykes utilising this foliation in domain C1. **C** – Poorly developed S_4 in a magma mingling zone of the HMG in domain C3. **D** – SE facing view of a leucogranite dyke and veinlets clearly shown to intrude along S_4 . **E** – typical S_4 defined by variably retrogressed fine-grained ultramylonite and protomylonitic porphyroclastic granodiorite augen gneiss in domains A and B. **F** – Ultramylonitization along S_4 in a leucogranite dyke also indicating the syn-tectonic nature of these granitic melts in domain C2.

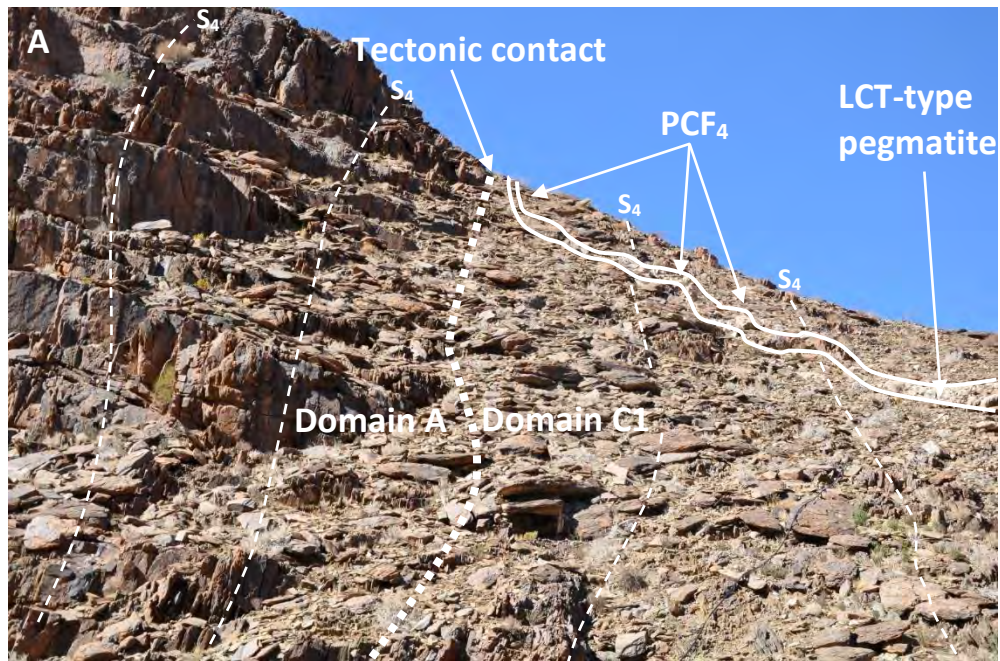


Figure 61: **A** – SE facing view of the tectonic contact between domain C1 and B, with S_4 prominently developed. A very important observation is that pegmatite crosscuts S_4 within domain C1 but is itself deflected by S_4 in domain B. PCF_4 folding of pegmatite is also clearly visible and shown to be syn-tectonic with respect to S_4 in domain B. **B** – N facing view of well-defined L_4 on a contact surface of leucogranite dyke in domain C1.



Figure 62: **A** – Rootless, isoclinal intrafolial F_4 fold of a leucogranite dyke in S_4 in domain C1. **B** - Rootless, isoclinal intrafolial F_4 fold of a leucogranite dyke in S_4 in domain C2. Note the shallow plunge of F_4 which is subparallel to the shallow plunges of L_4 in the area (e.g., figure 64).



Figure 63: **A** - Tight F_4 fold of S_4 banded ultramylonite with axial planar geometry and with bands being defined by fine-grained quartz ribbons and recrystallized feldspar in domain B. F_4 trend and plunge in alignment with L_4 trend and plunge. **B** - NW facing view of tight F_4 fold of S_4 banded ultramylonite with axial planar geometry, with bands being defined by fine-grained quartz ribbons and recrystallized feldspar in domain B.

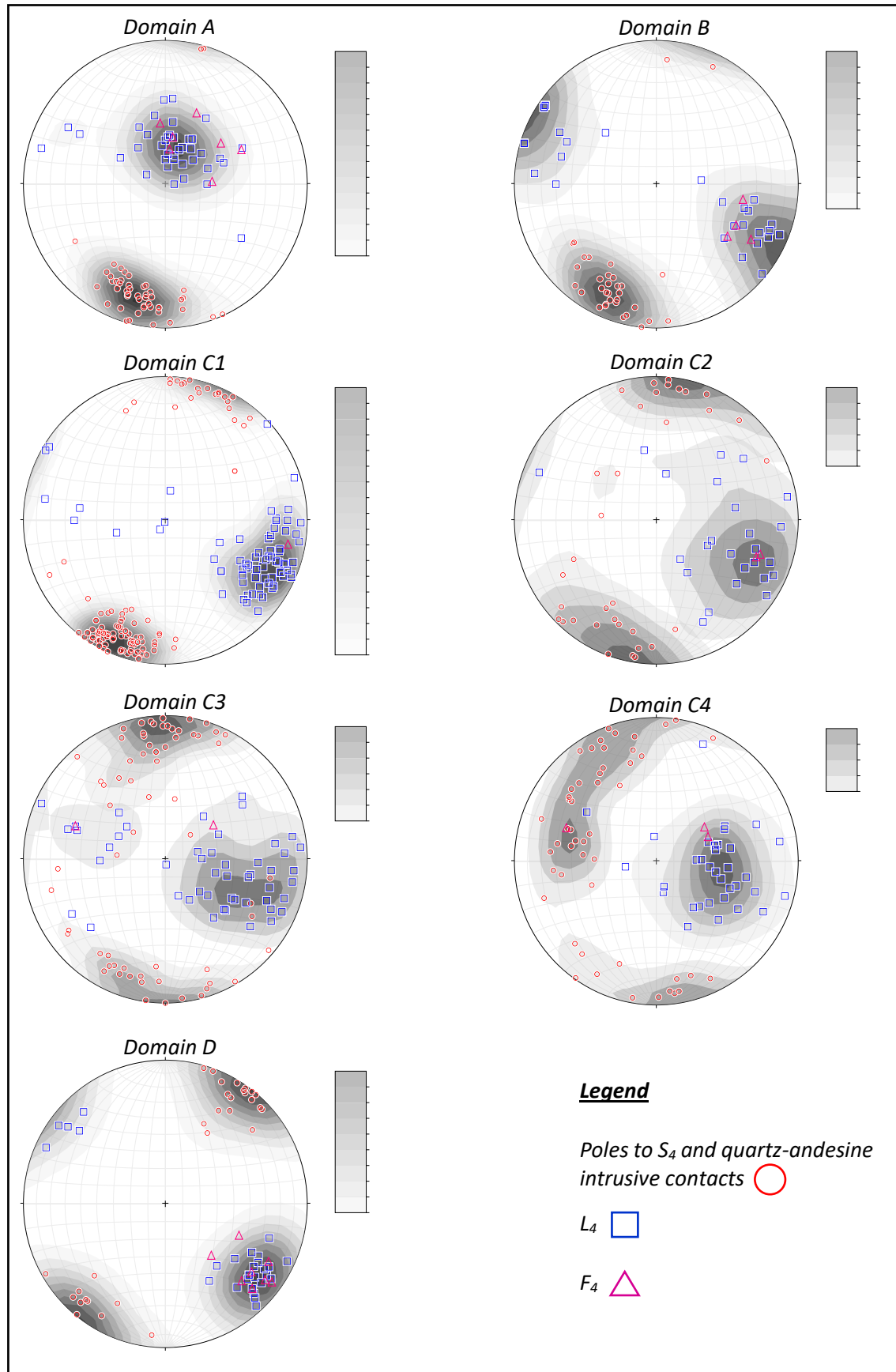


Figure 64: Lower hemisphere equal area stereographic projection of S_4 , L_4 and F_4 as separated by strain domain. Domain A: $nS_4 = 49$, $nL_4 = 39$; $nF_4 = 7$; Domain B: $nS_4 = 34$, $nL_4 = 31$; $nF_4 = 4$; Domain C1: $nS_4 = 107$, $nL_4 = 72$; $nF_4 = 1$; Domain C2: $nS_4 = 34$, $nL_4 = 25$; $nF_4 = 2$; Domain C3: $nS_4 = 66$, $nL_4 = 49$; $nF_4 = 2$; Domain C4: $nS_4 = 50$, $nL_4 = 34$; $nF_4 = 2$; Domain D: $nS_4 = 31$, $nL_4 = 28$; $nF_4 = 8$. Table 6 is a descriptive table which accompanies this data.

Table 6: Ranges of orientations for S_4 , L_4 and F_4 structural fabrics as observed within the study area. Structural orientations are given in true north. This table should be read in conjunction to figure 64. This ranges in orientations are qualitative only.

Domain	S_4	L_4	F_4	Comments
Domain A	Strikes 275 - 300°, moderate to steep dips 60 - 80° towards the N and NNE.	Trends 069 - 349° with moderate to steep plunges between 60 - 80° predominantly towards the NNE.	Trends and plunges sub-parallel to L_4	Diagnostically steeply dipping L_4 . Relatively incompetent domain consisting of unsheared to weakly sheared porphyritic granodiorite; porphyroclastic granodiorite augen gneiss.
Domain B	Strikes between 280 - 305°, dips 60 - 85° towards the NNE.	Trends 290 - 116°, with plunges moderate to shallow between 18 - 30°, predominantly towards the SE.	Trends and plunges sub-parallel to L_4	Transitional zone between domain A and domain C1 defined by the progressive reorientation of L_4 . This zone is dominated by mylonite and ultramylonite after unsheared to weakly sheared porphyritic granodiorite; porphyroclastic granodiorite augen gneiss.
Domain C1	Strikes 275 - 305°, dips 70 - 85° towards the NE; strikes 095 - 130°, dips 75 - 89° towards the SW.	Trends 087 - 134°, plunges are mostly shallow between 5 - 28° predominantly to the WSW	Trends and plunges sub-parallel to L_4	The plunges of L_4 are distinctly shallower as compared to domains A and B. Relatively competent domain dominated by mixed, sheared to weakly sheared undifferentiated hybrid mottled metagabbro rocks and minor xenoliths of gabbro, pyroxenite, troctolite, tonalite; metamorphic equivalents, belonging to the Tantalite Valley Complex Proper.
Domain C2	Strikes 273 - 323°, dips 60 - 80° towards the NE and NNE; strikes 076 - 134°, dips 65 - 85° towards the SSW and SW. Dips are however predominantly towards the NE and NNE.	Trends 151 - 027°, plunges moderately 35 - 75° towards the NE to SW. Plunges are however predominantly towards the WSW.	Trends and plunges sub-parallel to L_4	The plunges of L_4 are distinctly shallower as compared to Domains A and B. Grouping of L_4 distinctly low. Relatively competent domain dominated by mixed, sheared to weakly sheared gabbroic rocks and interfingering Eendoorn Suite granitic rocks; minor pyroxenite, troctolite, tonalite; metamorphic equivalents.
Domain C3	Strikes and dips highly variable, however appear to plot along the best fit plane of the pole trending 097° and plunging 51° WSW. However, predominantly striking 070 - 116°, dipping 55 - 85° S - SW; and striking 255 - 305°, dipping 65 - 85° NE.	Trends 075 - 125°, plunges 10 - 60° W-SW; trends 275 - 310°, plunges 30 - 60° WNW.	Trends and plunges sub-parallel to L_4	Structurally highly variable and directly influenced by the NW strain shadow of the TVC. This domain is considered to exhibit the lowest form of relative strain intensity. Relatively competent domain dominated by mixed, sheared to weakly sheared gabbroic rocks and interfingering Eendoorn Suite granitic rocks; minor pyroxenite, troctolite, tonalite; metamorphic equivalents.
Domain C4	Strikes and dips highly variable, however appear to plot along the best fit plane of the pole trending 079° and plunging 52° ENE. There is no clear grouping.	Trends 66 - 126°, plunges 40 - 65° WNW - WSW. The grouping is much tighter compared to S_4 .	Trends and plunges sub-parallel to L_4	Structurally highly variable and directly influenced by the NW strain shadow of the TVC. This domain is considered to exhibit the lowest form of relative strain intensity. Relatively competent domain dominated by mixed, sheared to weakly sheared gabbroic rocks and interfingering Eendoorn Suite granitic rocks; minor pyroxenite, troctolite, tonalite; metamorphic equivalents.
Domain D	Strikes 300 - 320°, dips 70 - 85° towards the NE; strikes 115 - 135°, dips 65 - 88° towards the SW.	Trends 115 - 140°, plunges 10 - 28° SW; trends 300 - 317°, plunges 5 - 20° NE	Trends and plunges sub-parallel to L_4	Relatively high strain domain dominated by mylonite, ultramylonite, cataclasite, phyllonite and sheared rocks. Some competent lithons of restitic/migmatitic grt-crd-bt-fsp pelite granulite; psammite gneiss and mafic granulite occur. Good grouping of structural fabrics.

Domains A, B, C1, C2, C3, C4 and D

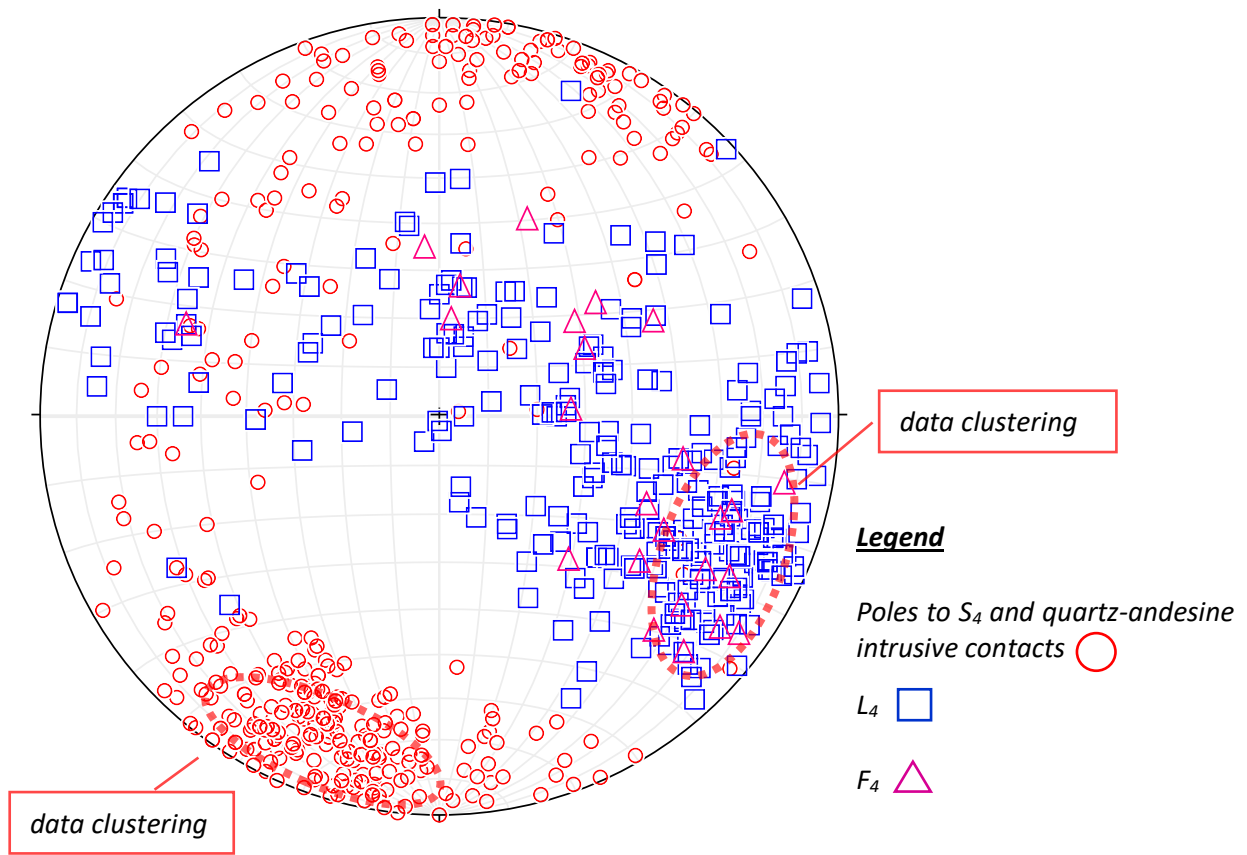


Figure 65: Lower hemisphere equal area stereographic projection of all S_4 , L_4 and F_4 measurements unseparated for the various domains. This dataset encompasses a total of 675 structural measurements.

4.4.2 Quartz vein contacts (QVC_4) and mineral stretching lineations ($QVCL_4$)

QVC_4 , defined by the sharp contacts of polyminerale quartz-dominant veins, and $QVCL_4$, defined by recrystallized quartz mineral stretching lineations on QVC_4 , are prevalent in domains C1, C2, and C3. They also appear to be older than PC_4 , PCL_4 and PCF_4 . QVC_4 possibly occurs as two sub-sets, one concordant and boudinaged with S_4 (e.g., figure 68) and one discordant with S_4 (e.g., figure 67). The possible sub-set which is concordant to S_4 appears to be associated with the phyllonite hosted scheelite veins, while the possible sub-set which is discordant to S_4 appears to be barren. It is also possible that the shallow dipping sub-set is directly related to pegmatite, and thus PC_4 , since they are so similarly orientated. There are not enough structural measurements and field occurrences to reliably determine geometrical trends for QVC_4 and $QVCL_4$, particularly between various domains, however, there appears to be a broad correlation with the orientations of S_4 , L_4 and F_4 , and possibly PC_4 , indicating a temporal and syn-tectonic association.

Figure 66 illustrates the general orientation of QVC_4 and $QVCL_4$ for both possible subsets.

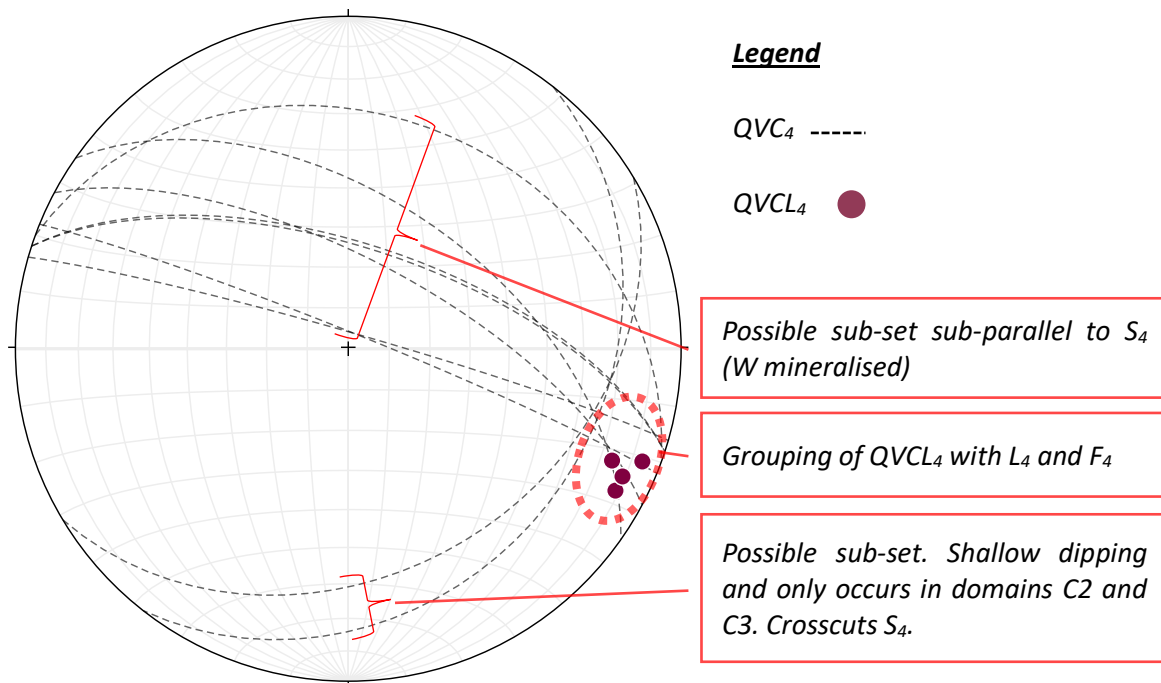


Figure 66: Lower hemisphere equal area stereographic projection of all QVC_4 and $QVCL_4$ measurements. Two possible sub-sets are indicated accordingly. The common $QVCL_4$ suggests that they are contemporaneous.



Figure 67: NW facing view the quartz veins comprising the shallow dipping, barren, and discordant sub-set. These veins intrude into the HMG in domain C2.

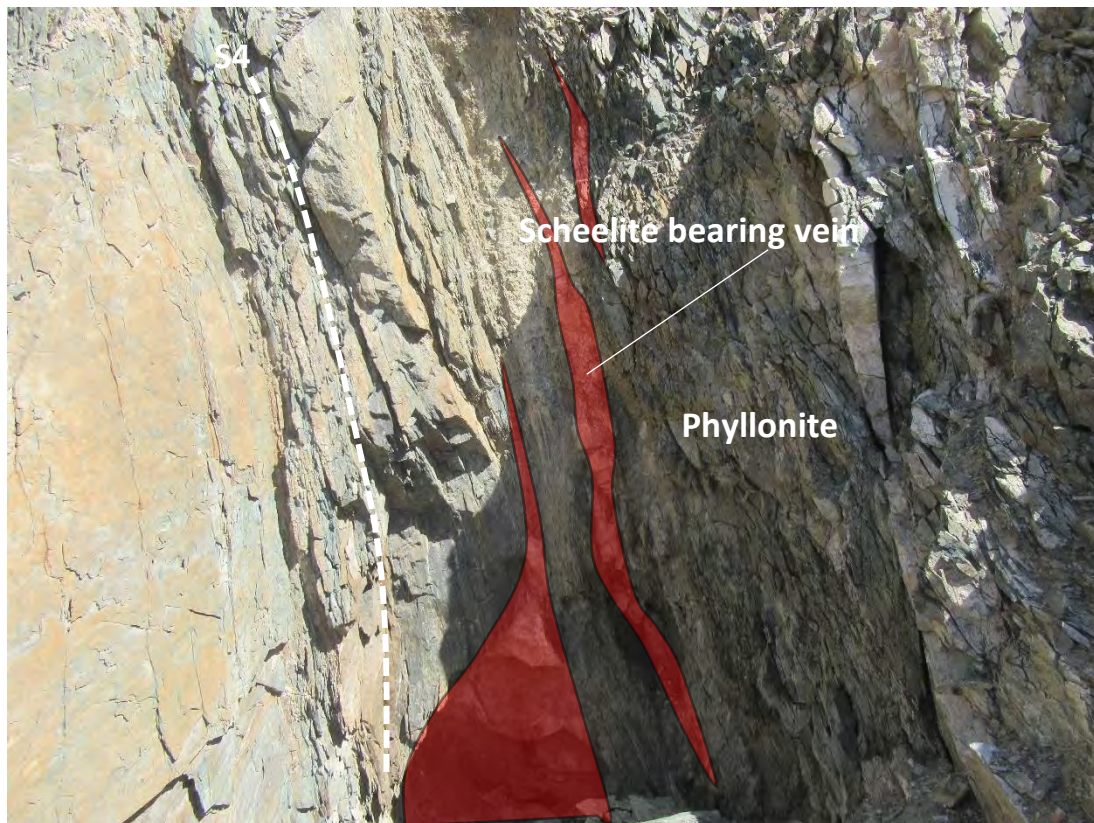


Figure 68: NW facing view of a the QVC₄ subset comprising steeply dipping (S_4 parallel) viz. phyllonite hosted quartz-feldspar-amphibole-biotite-scheelite vein which was worked in the past for scheelite.

4.4.3 Pegmatite contacts (PC_4), pegmatite contact lineations (PCL_4), and folding (PCF_4) of pegmatite contacts

PC_4 within the study area is defined by relatively sharp but slightly undulatory contact surfaces between pegmatites and their host rocks. The majority of PC_4 structural measurements occur within domains C1, C2 and C3, as these domains predominantly host the pegmatites. Within domains C1, C2 and C3 PC_4 is relatively shallow dipping and clearly crosscuts S_4 , and so also the leucogranite dykes (e.g., figures 71A and 71B). Within domains A, B and D PC_4 is sub-parallel to and syn-tectonic with respect to S_4 . The syn-tectonic nature of PC_4 within domains C1, C2 and C3 is exhibited through PCL_4 , defined by rodded recrystallised quartz-feldspar-mica aggregates on PC_4 , and PCF_4 , defined by gentle open folding of PC_4 (e.g., figures 71F and 71D). Trends and plunges of PCL_4 and PCF_4 are in most cases sub-parallel to that of F_4 and L_4 (figure 69). In rare cases PC_4 can also be observed to be syn-tectonic with respect to shallow dipping shear planes (figures 71B and 71E). PC_4 on average strikes between $330 - 017^\circ$ and dips between $14 - 17^\circ$ across all domains. PCL_4 on average trends $090 - 125^\circ$ and plunges $13 - 28^\circ$ across all domains.

Within domains C1, C2 and C3, PCF_4 folding of PC_4 (e.g., figures 71D and 71F) is most obvious in the thinner pegmatites. An idealised geometry for PCF_4 , presented in figure 70, can be derived from a best-fit approach towards a universal axial plane, fold limbs, and trend and plunge of a fold hinge, although unlikely to be highly accurate. This idealised PCF_4 can be represented by an axial plane striking 105° and dipping 87° SSW (upright), a fold hinge trending 106° and plunging 13° ESE (near horizontal), a northern fold limb striking 302° and dipping 39° NE, and a southern fold limb striking 074° and dipping 24° SE. The interlimb angle for this idealised PCF_4 is 123° (gentle to open) with a gentle verge towards the NE.

The orientation groupings between L_4 and F_4 , and PCL_4 and PCF_4 (figure 70), suggests a strong temporal association. There is generally little to no field evidence which indicates the development of an axial planar foliation within the folded pegmatites, however when considering the idealised geometry of PCF_4 , it is not unreasonable to suggest that the axial planes of PCF_4 are axial planar with respect to S_4 .

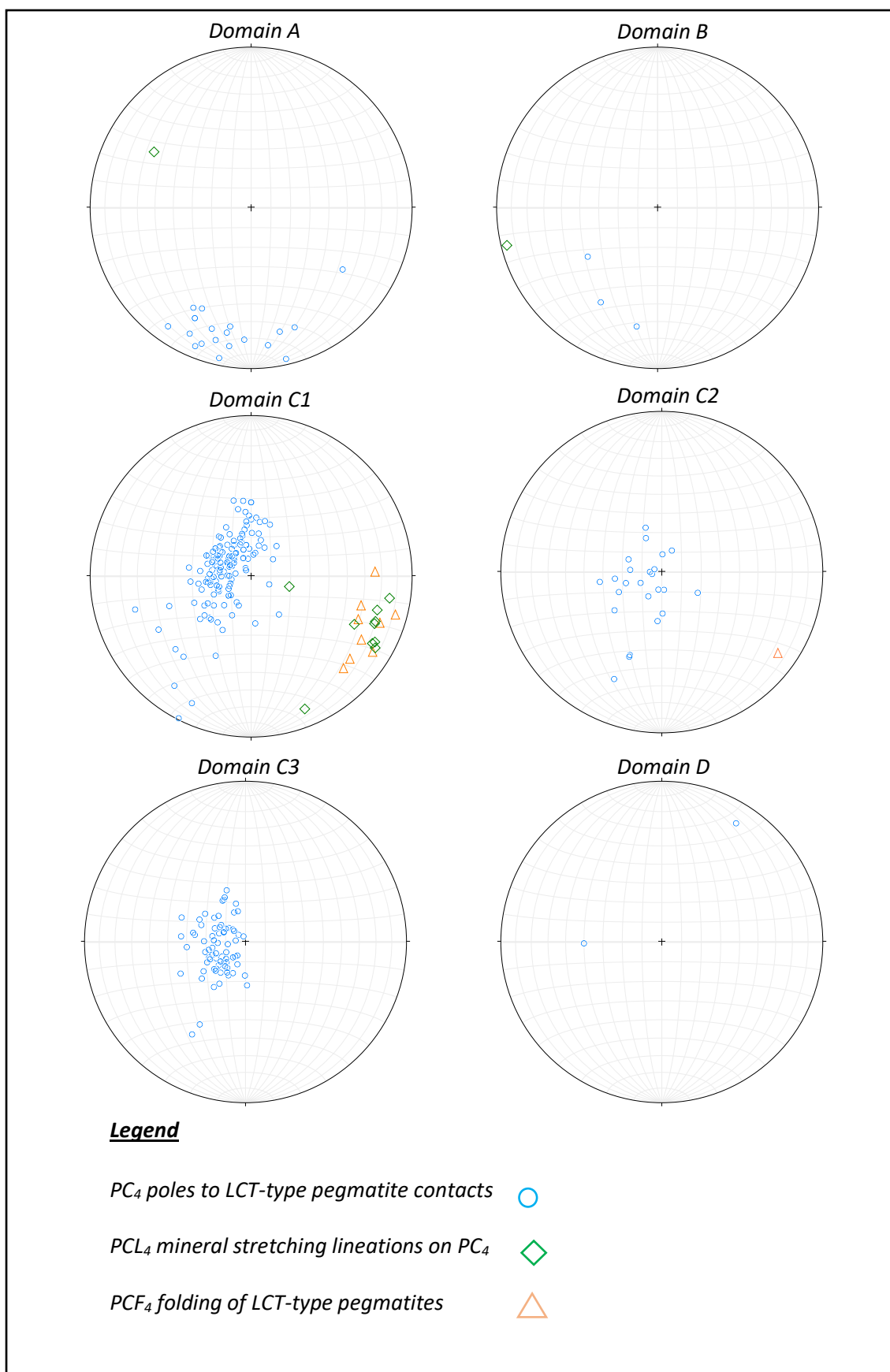


Figure 69: Lower hemisphere equal area stereographic projection of all PC₄, PCL₄ and PCF₄ measurements in domains A, B, C1, C2, C3 and D. No LCT-type pegmatites were encountered in domain C4. Domain A: nPC₄ = 20, nPCL₄ = 11, nPCF₄ = 0; Domain B: nPC₄ = 3, nPCL₄ = 1, nPCF₄ = 0; Domain C1: nPC₄ = 450, nPCL₄ = 9, nPCF₄ = 0; Domain C2: nPC₄ = 24, nPCL₄ = 1, nPCF₄ = 0; Domain C3: nPC₄ = 135, nPCL₄ = 5, nPCF₄ = 0; Domain D: nPC₄ = 2, nPCL₄ = 0, nPCF₄ = 0.



Domains C1, C2, and C3

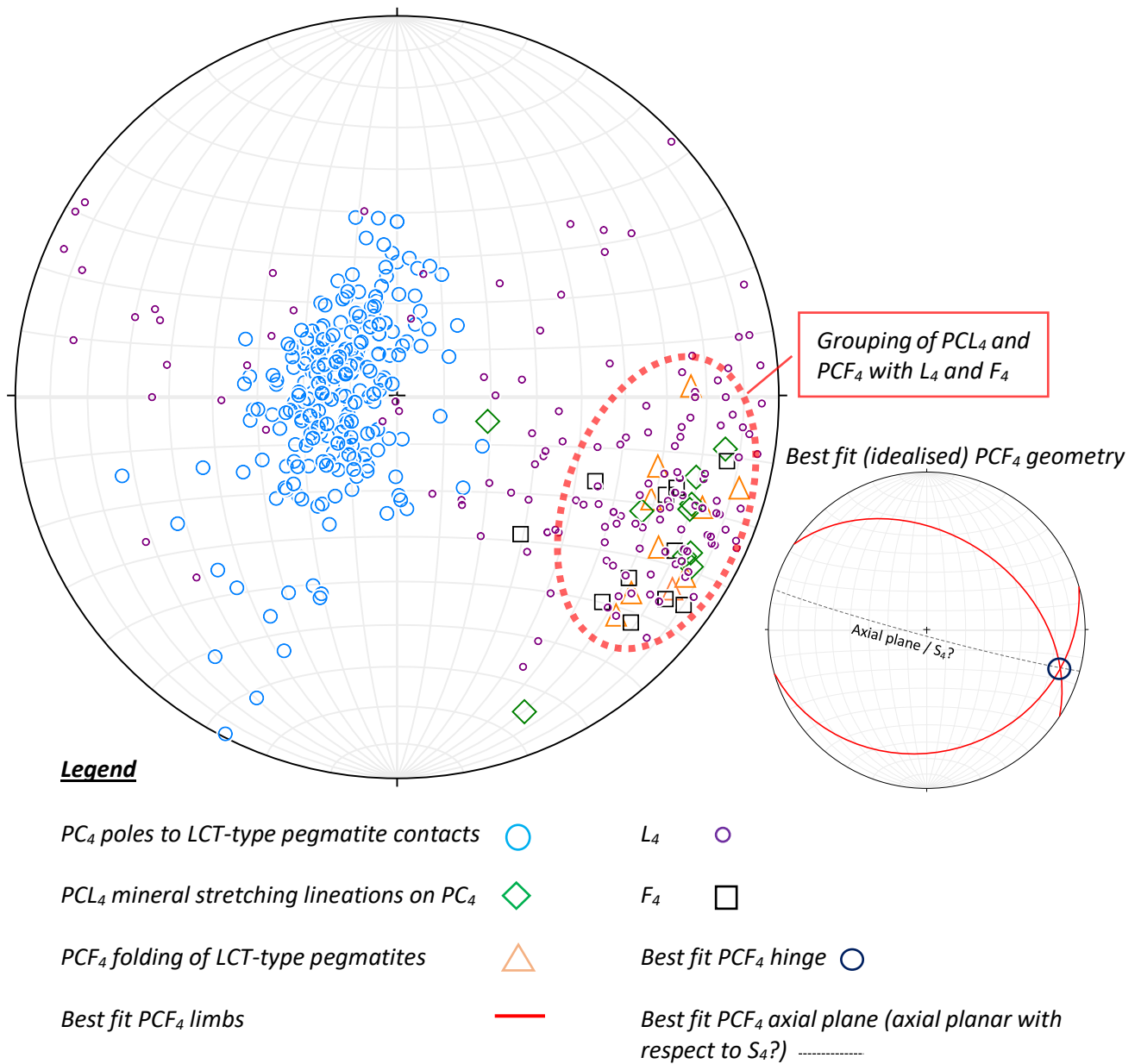


Figure 70: Lower hemisphere equal area stereographic projection of all PC_4 , PCL_4 and PCF_4 , as well as L_4 and F_4 measurements in domains C1, C2, C3.

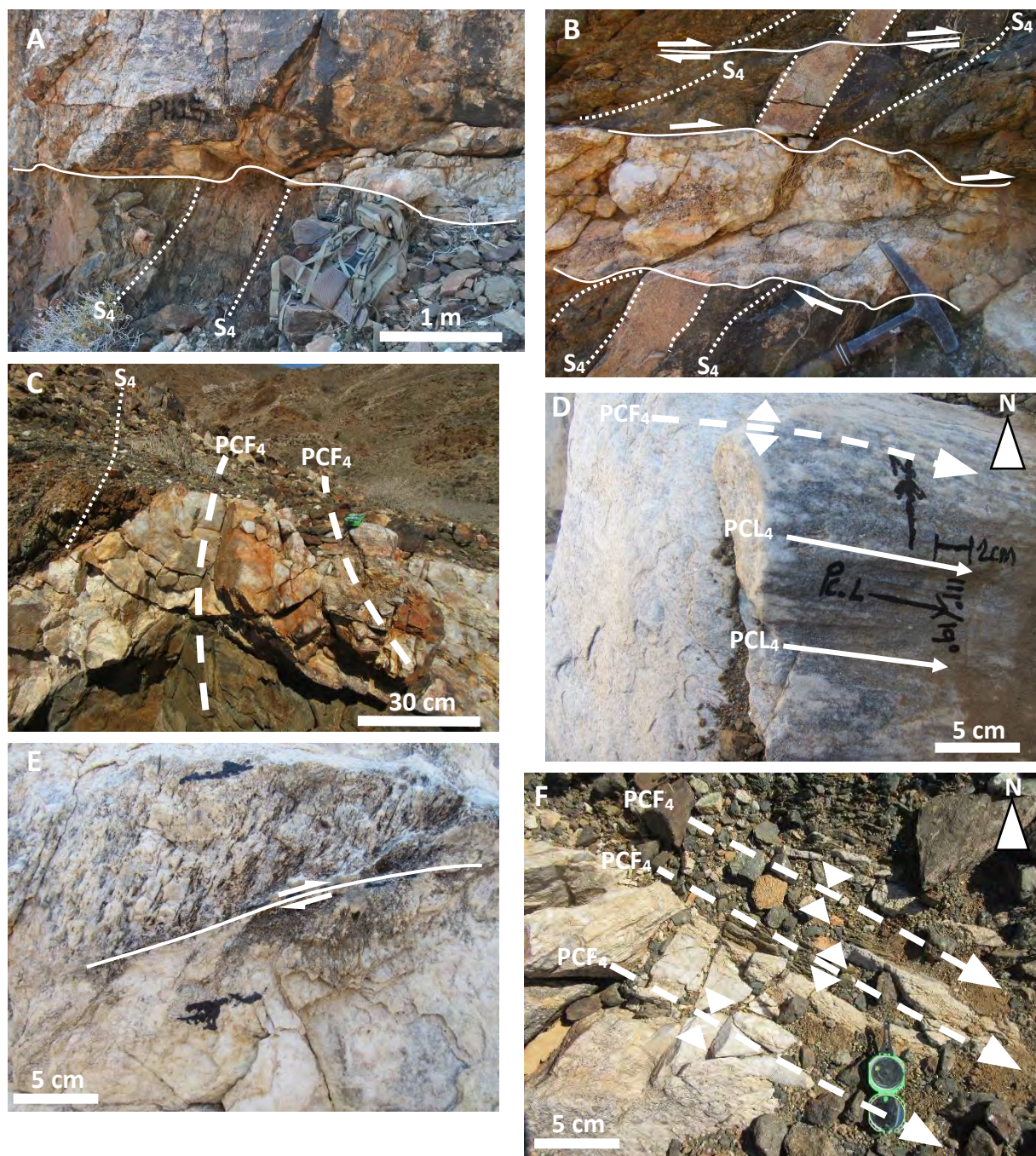


Figure 71: **A** – SE facing view of PC_4 crosscutting S_4 at high angles in domain C2. **B** – SE facing view of PC_4 crosscutting S_4 and a leucogranite dyke at a high angle, with minor displacement visible along the contact, in domain C1. **C** - Folded PC_4 defining PCF_4 in domain C1. **D** – PCL_4 mineral stretching lineation and PCF_4 on PC_4 . PCL_4 and PCF_4 are sub-parallel to one another. **E** – Minor shearing crosscutting an axial planar S_4 cleavage within LCT-pegmatite indicating syn-tectonic emplacement. **F** – A series of open and shallow plunging parasitic PCF_4 .

4.4.4 Post-D₄ structures (HBRC₅)

HBRC₅ appears to be the youngest fabric within the study area as it crosscuts all older fabrics at high angles (figures 72A – 72D). It is often represented by what also appears to be a sub-vertically dipping conjugate joint/fault set, with joints/faults often intersecting each other at angles significantly less than 60°. They are diagnostically associated with hydrothermal vein fillings and (propylitic) alteration envelopes. Both sinistral and dextral displacements can be observed on HBRC₅, although displacements are generally in the order of mm's to cm's. The orientation of the apparent joint/fault set appears to remain unchanged across all domains within the study area, also suggesting that it formed independently to D₄. Figure 72E indicates the idealized geometry of the apparent conjugate joint/fault of HBRC₅.

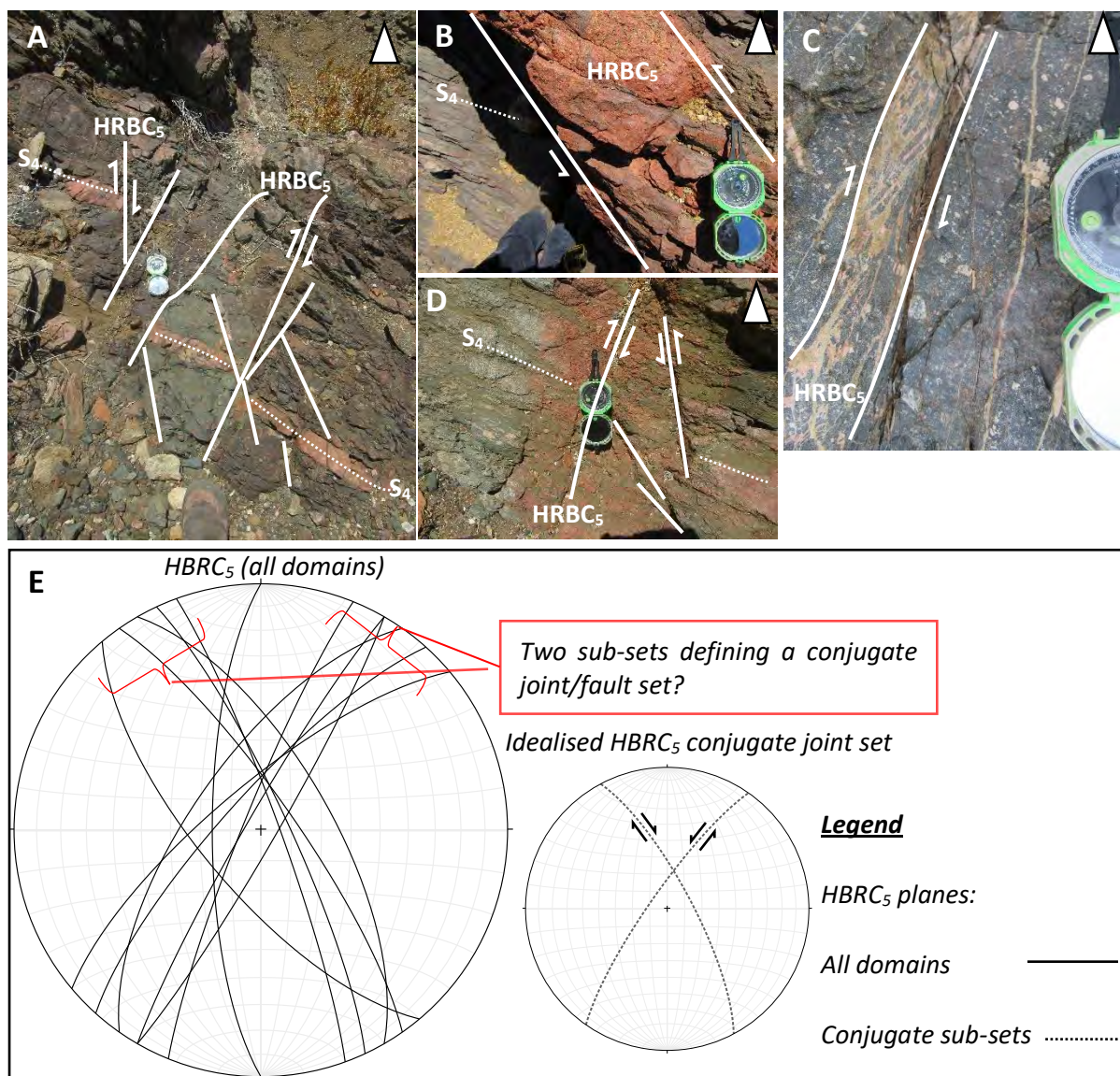


Figure 72: **A** – HBRC₅ conjugate set crosscutting S₄ at high angles and showing both sinistral and dextral displacements in domain C2. **B** – Relatively large HBRC₅ sinistral hydrothermal breccia crosscutting S₄ in domain A. **C** – HBRC₅ hydrothermal breccia in HMG in domain C1. **D** – HBRC₅ conjugate set crosscutting S₄ at high angles and showing both sinistral and dextral displacements in domain C3. Diagnostic hydrothermal alteration visible. **E** – Lower hemisphere equal area stereographic projects of HBRC₅ for all domains (nHBRC₅ = 12)

4.4.5 NFC late-stage brittle normal faults

A poorly developed brittle normal fault set (NFC) exists on reactivated S_4 surfaces (e.g., figures 73A and 73B). It is independent of the orientation of S_4 in the various domains. These faults are discrete and are not commonly accompanied by any distinctive mineral stretching lineations, obvious dip-slip or strike-slip movements, or hydrothermal alteration. The largest displacement which was observed within the study area was about 1.5 m down-dip on S_4 , with most displacements observed being in the order of mm's to cm's. It is not clear whether these faults belong to D_5 or any other deformation episode, however it is also unlikely that they belong to D_4 due to their discrete brittle nature and lack of mineral stretching lineations and hydrothermal alteration. No distinctive cross-cutting and relative timing relationship for these faults could be definitively established in the study area, except for that they are clearly younger than pegmatites.

Only two such NFC faults were observed to materially affect pegmatites F1, D0, D1 and D2. In very rare cases a very faint slickenside lineation, typically down-dip with respect to S_4 , could be observed, however this could not be reliably measured in the field.

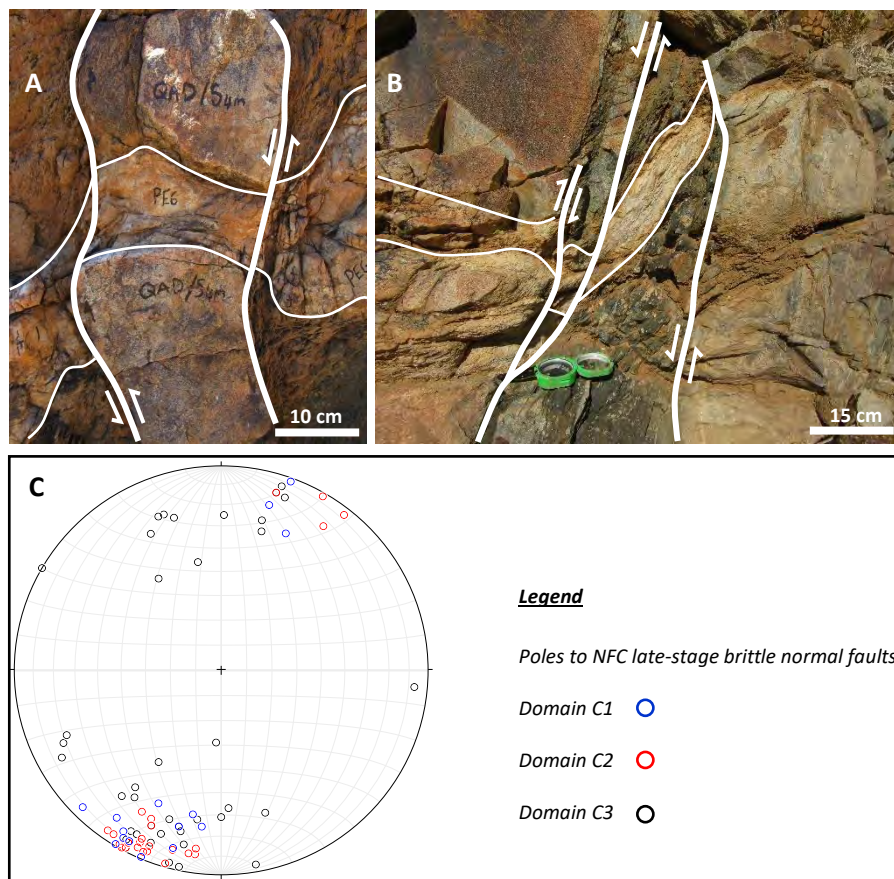


Figure 73: **A-** SE facing view of a relatively large NFC which displaces pegmatite, and which occurs on a reactivated S_4 surface, particularly along the contact of a syn- S_4 leucogranite dyke. **B-** SE facing view of NFC displacing LCT-type pegmatite. **C** – Lower hemisphere equal area stereographic presentation of poles to NFC for strain domains C1, C2, and C3 (nNFC = 82).

4.4.6 Stretching of mafic enclaves of the HMG

A general investigation was conducted on the stretching of finer grained melanocratic enclaves within comparatively high and low strain zones across strike of the entire HMG unit (figures 74 - 75). This investigation simply entailed the measuring of the long and short axes of the enclaves on a surface perpendicular to L_4 . Subsequently, it was assumed that the long axis of the enclaves likely approximates the local plane of maximum finite stretching (S_3), and that the short axis of the enclave likely approximates the local plane of maximum finite shortening (S_1). No factors regarding the original shape and orientation of the enclaves, the local partitioning of co-axial vs. non-coaxial strain, or their relative composition and rheology as compared to other portions of the HMG were considered. However, the enclaves and associated magmatic fabrics, whether exhibiting relatively lower or higher strains, generally show high structural integrity, cohesiveness, and lack of pervasive reworking and transposition within S_4 throughout the entire HMG. Overall, the enclaves exhibit lower strain textures.

This investigation was done to test the hypothesis, at least at a very high level, that magmatic fabrics within the HMG could potentially be syn-tectonic with respect to the MRPSZ, as alluded to by Kartun (1979). Based on this hypothesis it seems reasonable to assume that within the context of the MRPSZ the HMG as an entity would then have an aspect ratio at least equal to or less than the average aspect ratio of relatively high strain enclaves. The measurements made in this investigation are presented in figure 74.

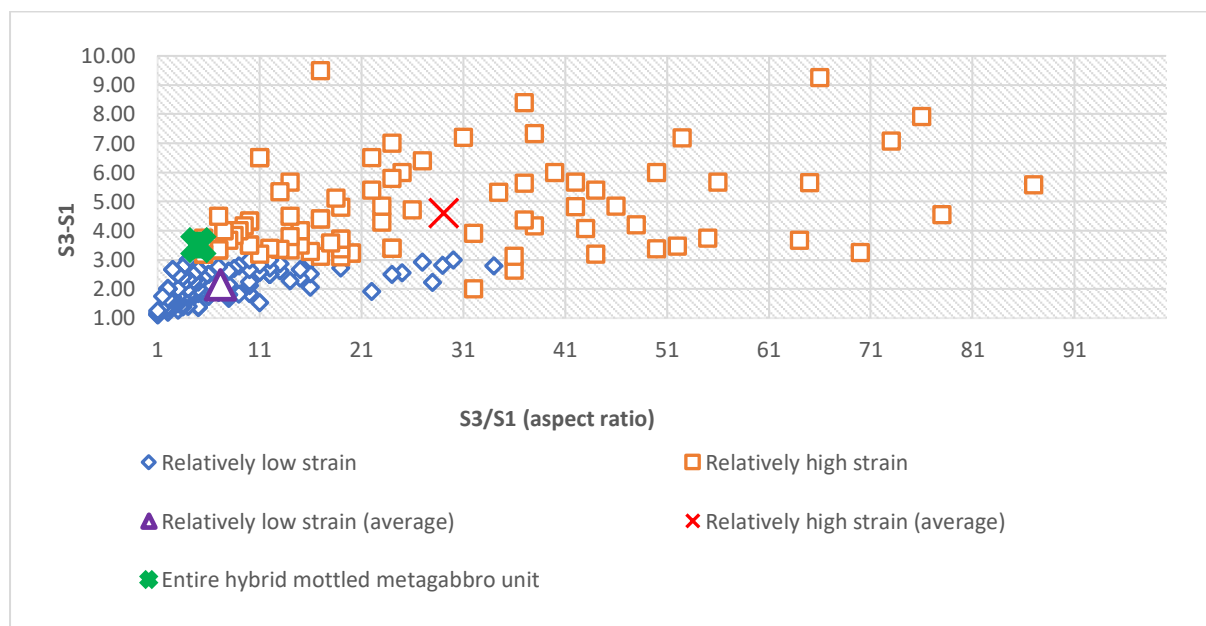


Figure 74: Aspect ratio measurements of “enclaves” ($n = 489$). These measurements assume that the long axis is sub-parallel to S_3 , and the short axis is sub-parallel to S_1 . The y-axis is arbitrary, and its purpose is only to separate the measurements which were made in relatively high strain zones from those made in relatively low strain zones. All measurements were collected on surfaces perpendicular to L_4 .

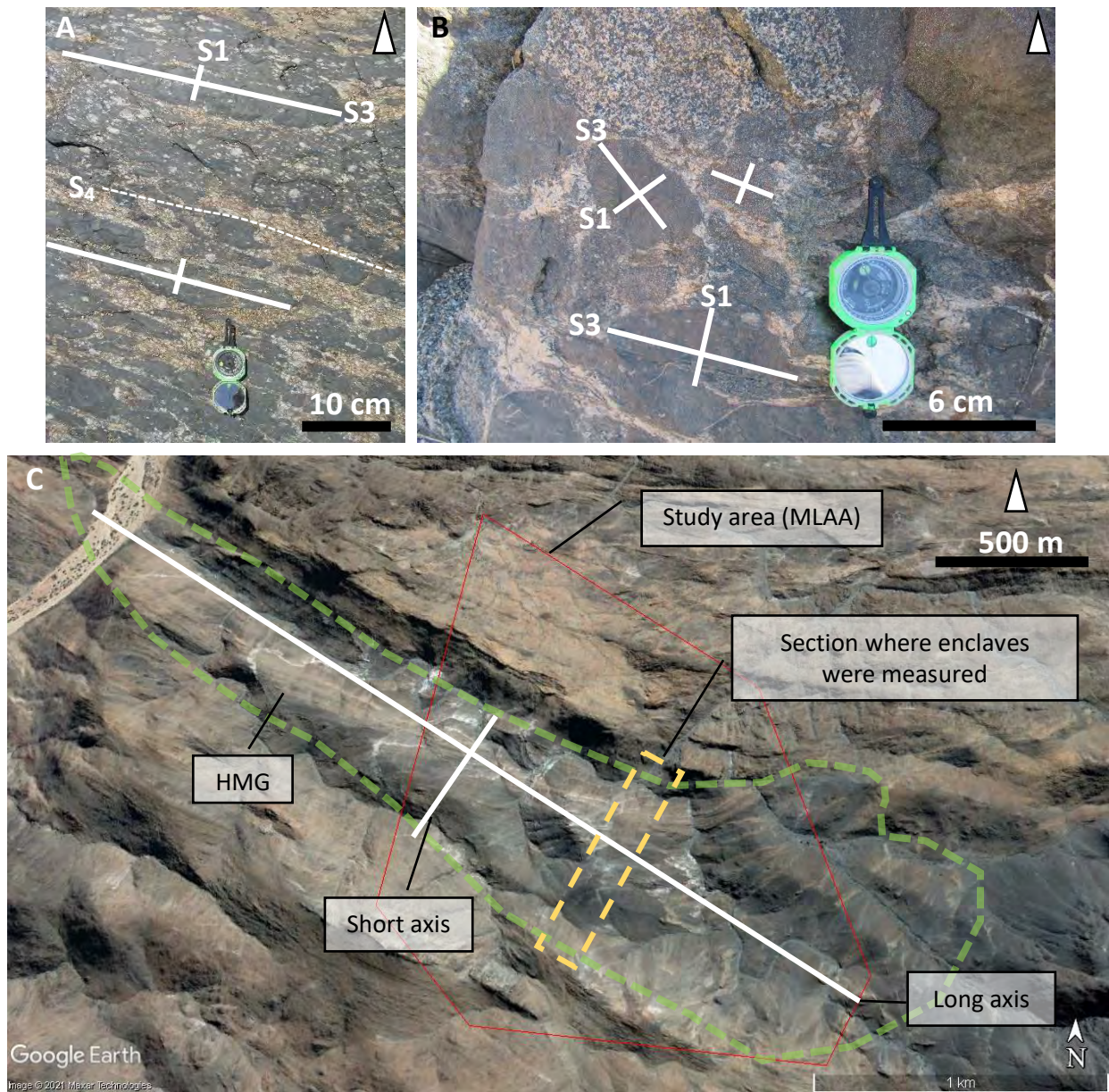


Figure 75: A - Example of highly elongated enclaves measured within relatively high strain zones. B – example of ovoid enclaves measured within relatively low strain zone. C – Overview of the extent of the HMG and the section which was followed during the measurement of relatively low and high strain mafic enclaves.

5 Economic aspects

5.1 Introduction

ORP is currently focussing its exploration efforts on 15 shallow dipping pegmatites occurring within the HMG. The field work completed to date (e.g., exploration drilling, mapping, and sampling) has already been highlighted in Chapter 3. The naming of these pegmatites and their associated clusters have been adopted from Young et al (1981). The pegmatites currently under primary investigation are D0 – D2, E1 – E8, and F1 (figure 76). ORP considers pegmatites F1 and D0 – D2 to be of the highest economic significance (e.g., Le Roux et al., 2020). Subsequently, the most recent work comprises a JORC Maiden Mineral Resource on the F1 and D0 – D2 pegmatites (Mullins and Petzer, 2021; table 7). ORP is currently drilling the E pegmatite cluster as well as the NW underground extension of the F1 pegmatite with the aim of expanding the current Mineral Resource. ORP presently does not consider the deposit to warrant significant lithium and/or niobium potential, however they are still investigating the recovery of spodumene as a potential by-product of tantalum mining (Le Roux et al., 2020). The JORC Maiden Mineral Resource is discussed in Chapter 5.2.

Investigation into the mineralogical characterization and beneficiation and recovery of tantalum minerals for the pegmatites of primary economic interest is currently ongoing by third party contractors. Previous work, aimed at broadly understanding the nature of tantalum mineralisation and at designing a preliminary minerals processing flow sheet for the beneficiation and recovery of tantalum, was conducted on a 5.5-ton composite bulk sample of the F1 pegmatite (e.g., Bezuidenhout et al., 2020). This work suggested that a 25 % Ta₂O₅ concentrate could be produced at an 68 % recovery.

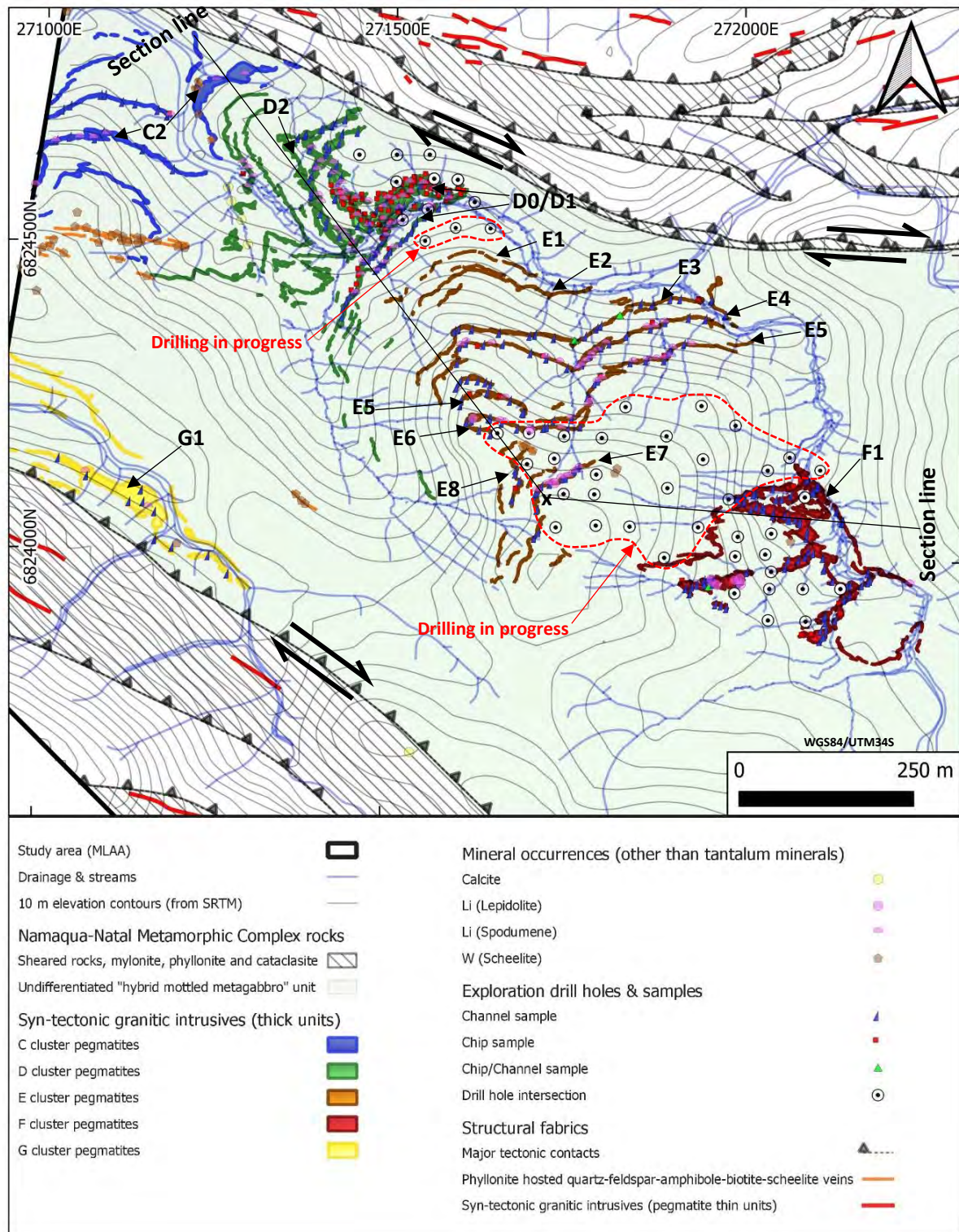


Figure 76: Overview of the pegmatites of primary economic interest comprising the Mineral Resource for the Swanson Tantalum Deposit. The areas which are currently being drilled are indicated. The section which correlates to the "section line" is presented in figure 77.

5.2 Mineral Resources

ORP has to date declared a JORC Maiden Mineral Resource of 1.2 Mt (Indicated and Inferred) @ 412 ppm Ta₂O₅, 76 ppm Nb₂O₅ and 0.29 % Li₂O (at an applied cut-off grade of 236 ppm Ta₂O₅ and a minimum thickness of 1 m) over four outcropping LCT-type pegmatites for Swanson Tantalum Deposit. This Mineral Resource encompasses pegmatites D0, D1, D2 and F1 (e.g., Mullins and Petzer, 2021; figures 76 - 77 and table 7). The economic priority of these pegmatites was determined by their perceived average thickness, amenability to open castable mining operations, and estimated average Ta₂O₅ grade (Le Roux et al., 2021). The geological and grade continuity of the pegmatites was found sufficient to classify the reasonably well-explored areas as Indicated Resources, with Inferred Resources being extrapolated 50 m beyond the last front of sampling (Mullins and Petzer, 2021). The thicknesses of the D0 – D2 and F1 pegmatites has been established through modelling of the hanging wall and footwall contacts and the Ta₂O₅, Nb₂O₅ and Li₂O grades have been estimated using ordinary kriging, with geostatistical continuity being established through variographic analysis. A global specific gravity of 2.60 was applied to all the pegmatites (Mullins and Petzer, 2021).

The current MRE has identified a total of 663 kt of Indicated Resource @ 431 ppm Ta₂O₅, 76 ppm Nb₂O₅ and 0.28 % Li₂O, and a total of 551 kt of Inferred Resource @ 388 ppm Ta₂O₅, 75 ppm Nb₂O₅ and 0.30 % Li₂O (Mullins and Petzer, 2021). However, the Mineral Resource and its various reported categories (e.g., JORC, 2012; “Inferred” “Indicated”, “Measured”, “Reserves”) for the Swanson Tantalum Deposit is likely to change as ORP’s mineral exploration activities are still ongoing.

The average grade of 412 ppm Ta₂O₅ for the current Mineral Resource indicates that it lies significantly above the average Mineral Resource grade of ca. 234 ppm Ta₂O₅ for peer group LCT-type pegmatite hosted tantalum deposits globally and holds some of the highest tantalum grades in the world, albeit it at relatively low tonnages (e.g., figure 78; Mullins and Petzer, 2021). With an average Ta₂O₅:Nb₂O₅ ratio of 7.5, the current Mineral Resource is also considered to be of exceptionally pure tantalum tenor, which is generally more desirable to the market than a high niobium tenor (e.g., Simandl et al., 2018).

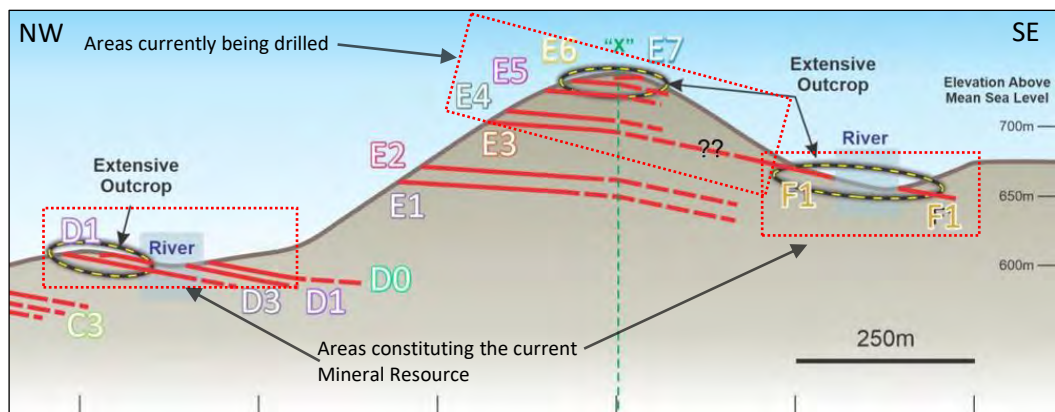


Figure 77: Schematic section of pegmatites constituting the Swanson Tantalum Deposit (source: <https://arcadiaminerals.global/>). The approximate section line is indicated on figure 76.

Table 7: The total Indicated and Inferred Mineral Resources for the Swanson Tantalum Deposit after Mullins and Petzer (2021): currently estimated at 1,214 kt @ 412 ppm Ta_2O_5 , 76 ppm Nb_2O_5 , and 0.29% Li_2O . The Mineral Resource was estimated for pegmatites above 1 m in thickness, and at a cut-off grade of 236 ppm Ta_2O_5 .

Classification	Pegmatite	Mass (kt)	Ta_2O_5 (ppm)	Nb_2O_5 (ppm)	Li_2O (%)
Indicated	D0	4.6	289	77	1.06
	D1	221.1	372	82	0.55
	D2	280.5	439	82	0.20
	F1	157.4	504	57	0.03
	Total	663.5	431	76	0.28
Inferred	D0	79.7	354	54	0.87
	D1	188.4	337	85	0.34
	D2	214.0	407	80	0.13
	F1	61.9	527	55	0.01
	Total	544.0	389	75	0.30
Indicated + Inferred	D0	84.3	351	55	0.88
	D1	409.5	356	83	0.45
	D2	494.4	425	81	0.17
	F1	219.2	510	56	0.02
	Total	1207.5	412	76	0.29

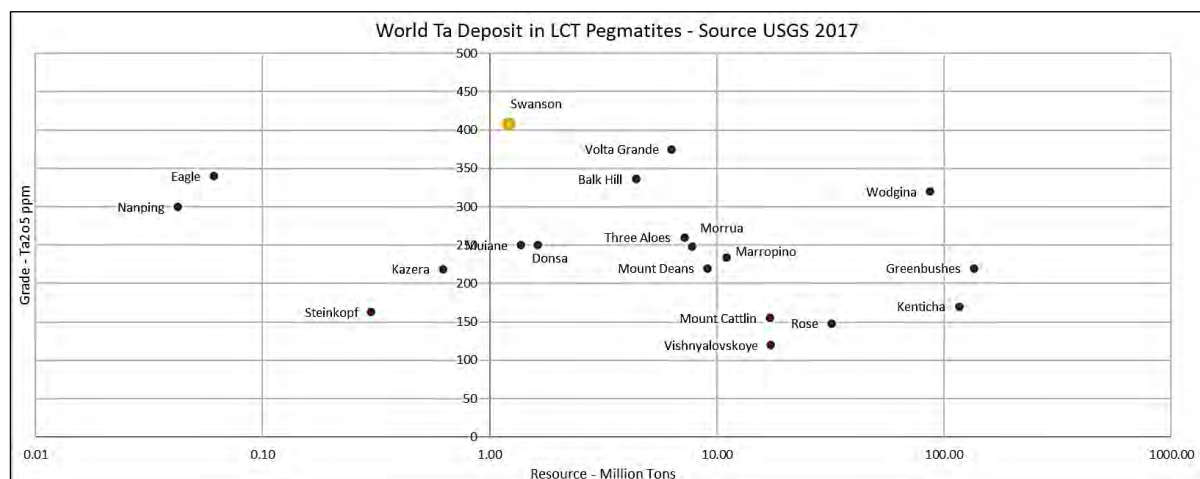


Figure 78: USGS Niobium and Tantalum: Critical Mineral Resources of the United States; Snowden's analysis of the Swanson Tantalum Deposit Mineral Resource as compared to global peer group tantalum deposits taken from Mullins and Petzer (2021).

5.3 Pegmatites of primary economic interest

Only the pegmatites which have been drilled and which are in the process of being drilled will be discussed here. These are pegmatites F1, E1 – E8 and D0 – D2. The existing exploration drill hole intersections and their respective weighted average Ta₂O₅ grades used in the Mineral Resource Estimation (MRE) by Mullins and Petzer (2021) are given in table 8.

Approximately 76 % of the reported tonnage of the current Mineral Resource is contained in the D0 – D2 pegmatites. The average Ta₂O₅ grades of the F1 pegmatite is 23 % higher at 504 ppm Ta₂O₅ versus 408 ppm Ta₂O₅ for D0 – D2 pegmatites. Lithium grades are lower for the F1 pegmatite than in the D0 – D2 pegmatites. The D0 pegmatite has the highest average Li₂O₅ grade of 0.88 (Mullins and Petzer, 2021)

Table 8: Exploration drill holes and weighted average Ta₂O₅ grades for significant intersections as used in the Mineral Resource Estimation by Mullins and Petzer (2021). Nb₂O₅ and Li₂O₅ have been omitted from this table. All coordinates are provided in WGS84-UTM34S datum.

Hole No	Pegmatite	X	Y	Z	EOH	From	To	Thickness	Ta ₂ O ₅
				mamsl	m	m	m	m	ppm
F1_DP_02	F1	272052	6823952	703.0	11.67	6.05	8.14	2.09	343
F1_DP_03	F1	272100	6823953	695.0	11.31	9.71	10.78	1.07	507
F1_DP_04	F1	272002	6823944	709.0	9.25		Drilled as confirmation		
F1_DP_05	F1	272002	6824004	706.4	4.36	1.06	2.93	1.87	618
F1_DP_06	F1	272154	6823954	682.0	7.73	3.75	5.18	1.43	399
F1_DP_07	F1	272045	6824008	698.0	12.14	6.24	8.44	2.20	275
F1_DP_08	F1	272005	6824036	703.1	11	6.33	8.92	2.59	459
F1_DP_09	F1	272051	6823901	713.0	12.39	10.38	11.89	1.51	665
F1_DP_10	F1	272054	6823980	693.4	7.33	0.23	2.88	2.65	272
F1_DP_11	F1	272105	6823900	698.3	12.2	9.30	11.97	2.67	309
F1_DP_12	F1	272053	6824042	689.0	14.13	3.68	6.24	2.56	374
F1_DP_13	F1	272100	6824102	660.0	4.97	0.43	2.59	2.16	361
F1_DP_14	F1	272003	6823900	720.0	7.89	2.70	4.82	2.12	421
F1_DP_16	F1	272077	6824166	656.1	9.7	4.77	7.10	2.33	519
D_DP_01	D1/D0	271550	6824560	612.5	20.87	3.63	7.76	4.13	229
D_DP_02	D1/D0	271514	6824542	611.6	20.73	2.21	6.08	3.87	339
D_DP_03	D1/D0	271450	6824647	656.0	33.19	8.47	15.70	7.23	398
D_DP_04	D1/D0	271551	6824649	641.0	27.68	10.75	12.16	1.41	350
D_DP_05	D1/D0	271504	6824648	646.3	30.41	4.08	9.33	5.25	458
D_DP_06	D1/D0	271504	6824604	632.1	21.31	1.54	9.53	7.99	273
D_DP_07	D1/D0	271558	6824610	625.2	21.51	0.00	8.67	8.67	169
D_DP_08	D1/D0	271592	6824609	626.5	8.09	1.50	2.73	1.23	413
D_DP_09	D1/D0	271617	6824573	614.7	29.99	5.04	5.77	0.73	358
D_DP_01	D2	271550	6824560	612.5	20.87	13.05	18.05	5.00	439
D_DP_02	D2	271514	6824542	611.6	20.73	11.61	13.16	1.55	427
D_DP_03	D2	271450	6824647	656.0	33.19	25.19	29.37	4.18	325
D_DP_04	D2	271551	6824649	641.0	27.68	20.90	27.09	6.19	288
D_DP_05	D2	271504	6824648	646.3	30.41	25.52	28.92	3.40	396
D_DP_06	D2	271504	6824604	632.1	21.31	13.02	16.03	3.01	237
D_DP_07	D2	271558	6824610	625.2	21.51	16.21	17.50	1.29	253
D_DP_08	D2	271592	6824609	626.5	8.09	7.80	Stopped - water loss		357
D_DP_09	D2	271617	6824573	614.7	29.99	9.58	19.13	9.55	260

5.3.1 The F1 pegmatite

The F1 pegmatite is the south-eastern most pegmatite comprising the Swanson Tantalum Deposit. It is situated closest in proximity to the TVC proper. On average the F1 pegmatite (PC₄) strikes 330° and dips 17° SW and attains an average thickness of approximately 1.30 m for the area evaluated in the MRE (Mullins and Petzer, 2021; this study). The F1 pegmatite consistently thins towards the southeast and thickens towards the northwest. In the northwest portions, drilling has regularly intersected > 2 m of pegmatite, suggesting that the pegmatite continues to thicken underground towards the northwest. ORP is currently drilling these underground portions. There is speculation that either the E4, E5 or E6 pegmatites may be an up-dip extension of the F1 pegmatite. This hypothesis is currently being tested with ongoing exploration (figure 77). The F1 pegmatite is gently and openly folded (PCF₄) with the fold axes trending NW-SE.

The average grade and tonnage of the explored portions of the F1 pegmatite, as included in the MRE, is 219 kt at 505 ppm Ta₂O₅, 56 ppm Nb₂O₅ and 0.015 % Li₂O. This grade and tonnage comprise Mineral Resources of Inferred and Indicated categories respectively (table 7 and figures 79 – 80; Mullins and Petzer, 2021). The univariate statistics for the data points used for the F1 pegmatite in the MRE are presented in figure 81. The 100-ton bulk sample currently under investigation was collected from the F1 pegmatite.

The F1 pegmatite is bound by a NW-SE late-stage normal fault (NFC) on its southwestern contact. It does not continue to occur to the southwest of this fault. It is likely that pegmatite which was on its south-western side has eroded away due to its relative up-throw. There are several such subordinate late-stage normal faults visible within the F1 pegmatite. The maximum throw for such faults was observed to be about 1.5 m.

The F1 pegmatite is largely texturally homogenous. It is dominated by sugary albite with subordinate quartz, zinnwaldite and lepidolite. There are very faint indications of spodumene being present, however in most cases it is altered to zinnwaldite and/or lepidolite. Ovoid perthitic feldspar, although rare, can be seen to contain intergrowths of blebby quartz. This may be some semblance of a crude graphic texture. Faint cm-scale layering is defined by ribbony bands richer in sugary albite, quartz, zinnwaldite and/or lepidolite. Tantalite and microlite occur as fine-grained and disseminated crystals throughout the pegmatite. The pegmatite is not obviously zoned.

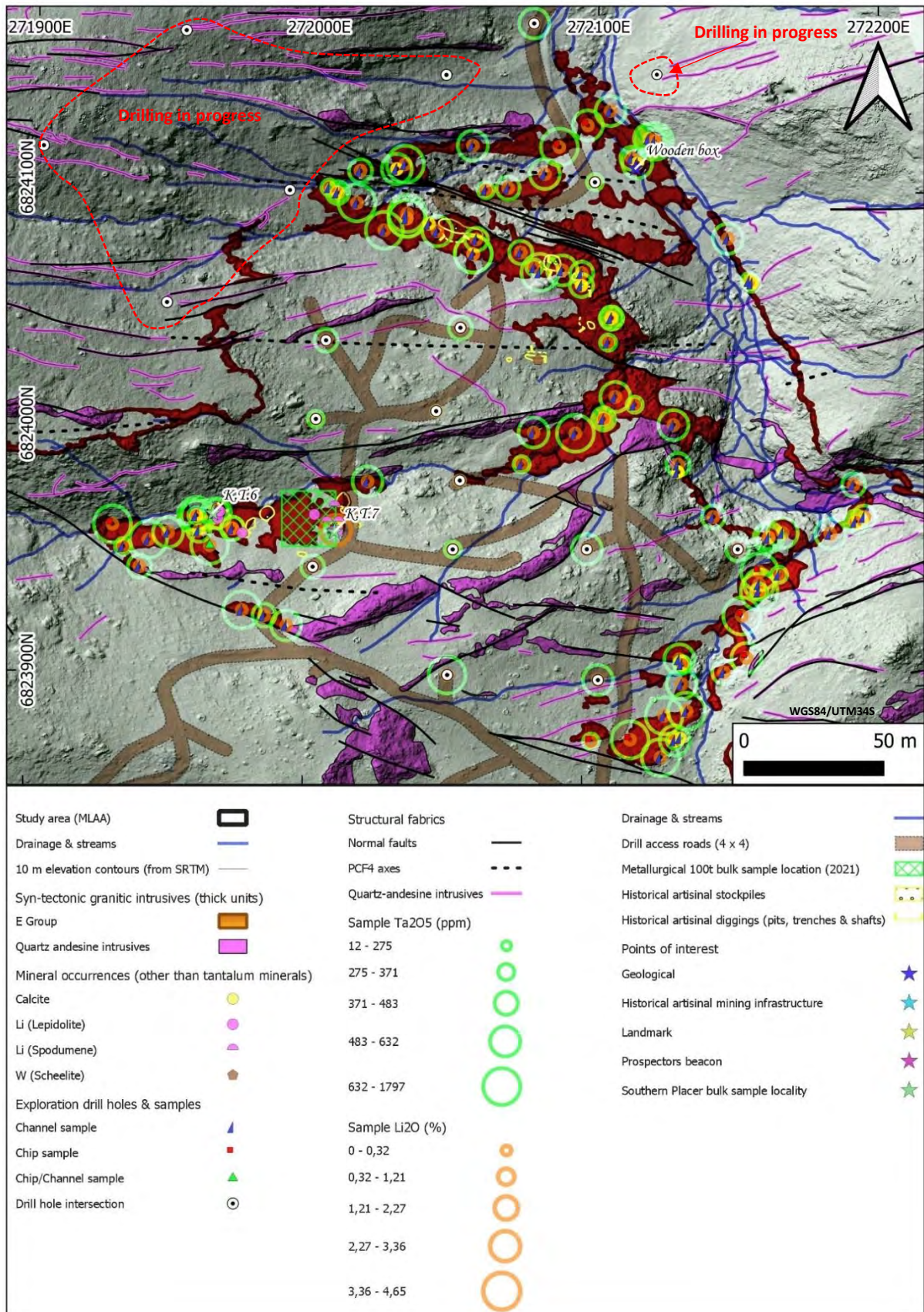


Figure 79: Overview map of the F1 pegmatite and all the exploration samples and their results, as used in the Mineral Resource Estimation of Mullins and Petzer (2021).

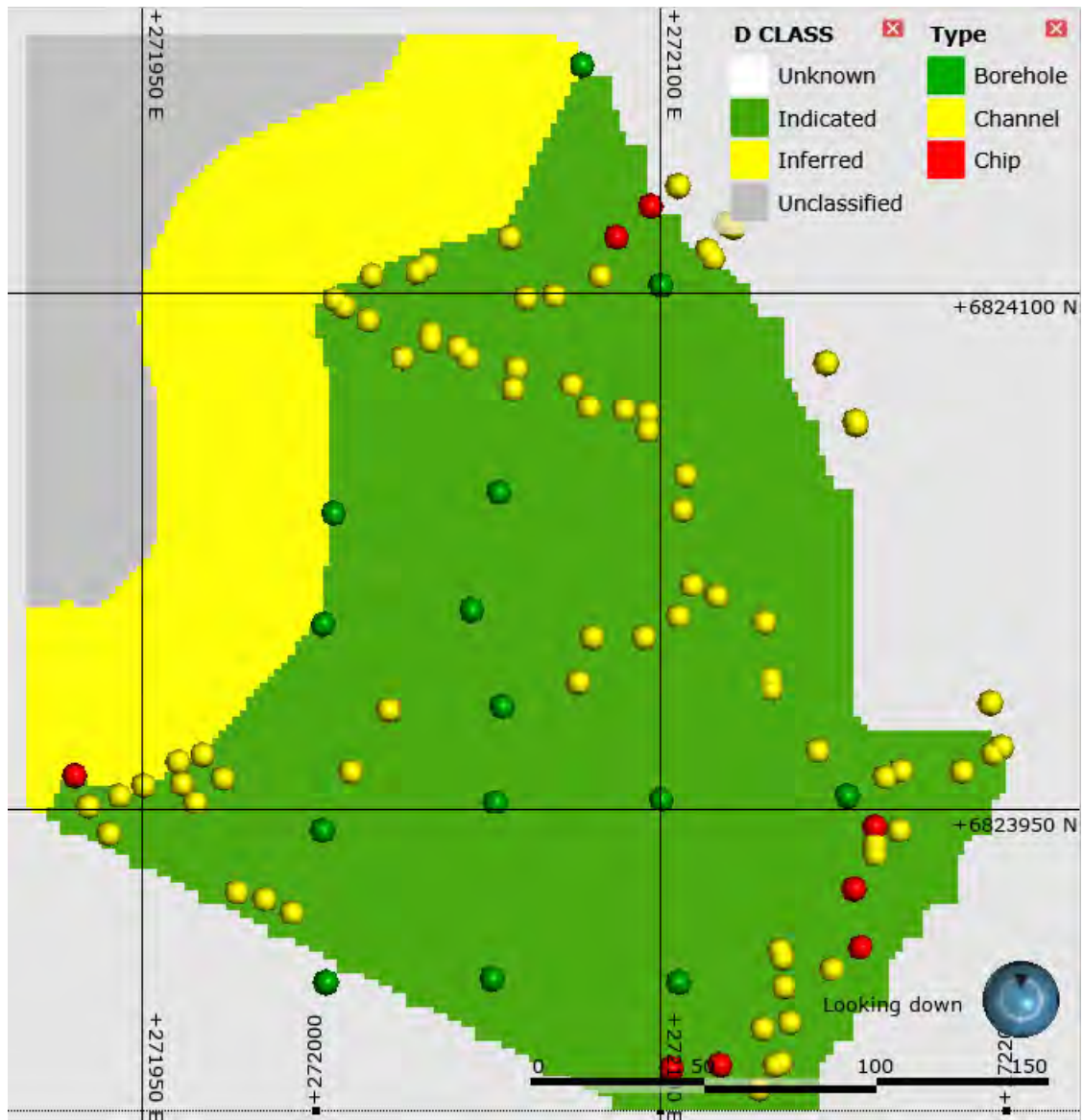


Figure 80: Overview map of the F1 pegmatite in terms of the Mineral Resource categories. After Mullins and Petzer (2021).

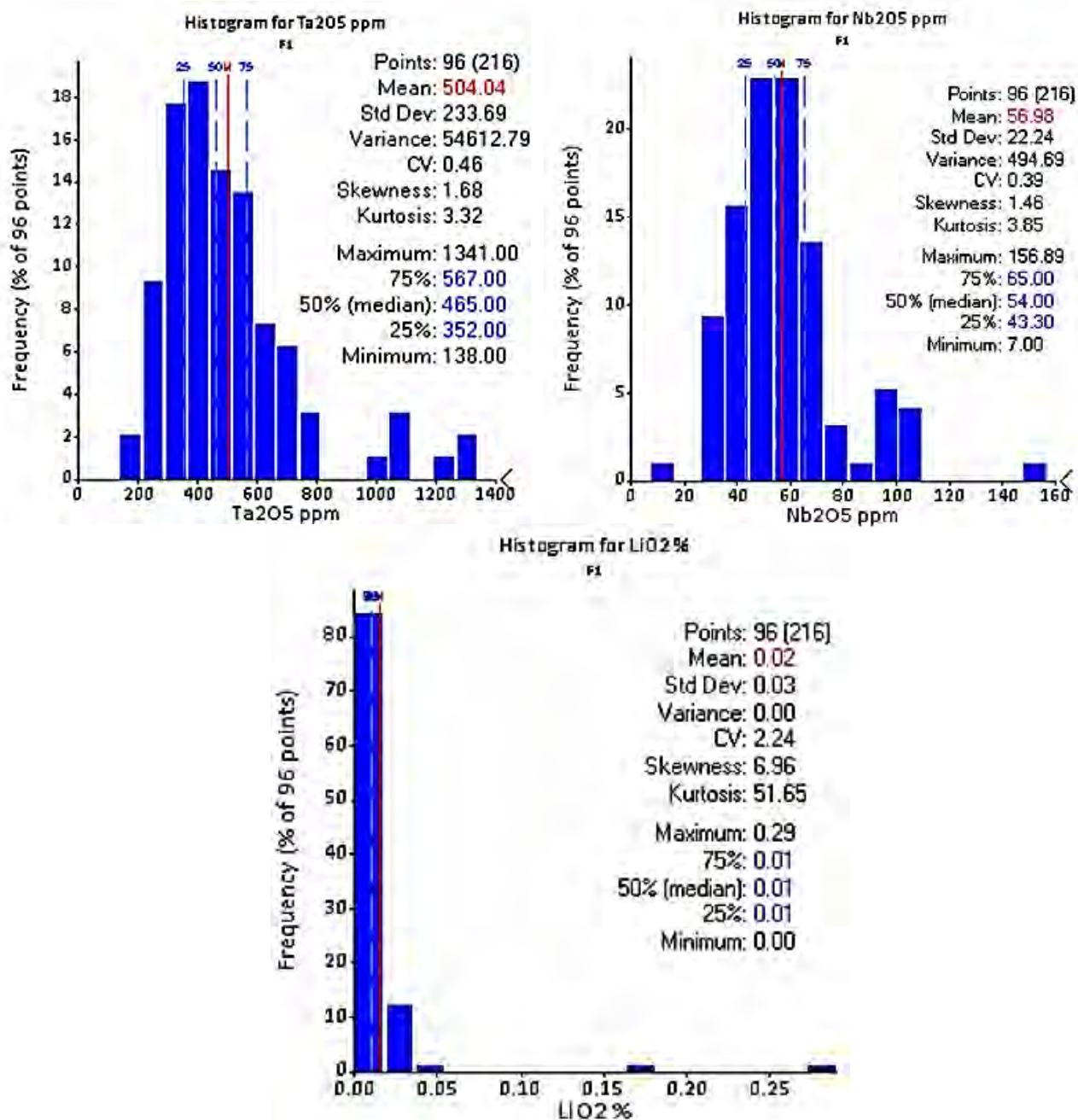


Figure 81: Univariate statistics for Ta₂O₅, Nb₂O₅ and Li₂O grades for all data points used in the Mineral Resource Estimation for the F1 pegmatite. Modified after Mullins and Petzer (2021).

5.3.2 The E pegmatite cluster

The E pegmatite cluster, comprising pegmatites E1 – E8, represents the central portions of the Swanson Tantalum Deposit (figure 82). There is currently no Mineral Resource which encompasses these pegmatites. Drilling is currently underway to test the hypothesis that the E4, E5 or E6 pegmatites might represent the up-dip extension of the F1 pegmatite. This drilling is also being conducted to delineate small portions of easily accessible and potentially open castable Mineral Resource on the E7 and E8 pegmatites. Large areas outcropping areas of the E pegmatite cluster are not easily accessible due to difficult terrain. Therefore, most of the E-pegmatite cluster is likely to only constitute underground Mineral Resources in the course of ongoing exploration.

Based on the exploration work done by ORP to date, the average Ta_2O_5 grades for these pegmatites are considered high. The weighted average Ta_2O_5 grades for the E –pegmatite cluster, as determined from all ORP's exploration channel sampling to date, is given in table 9.

Table 9: Weighted average grades of the individual pegmatites comprising the E pegmatite cluster as based on exploration channel sampling completed to date.

Pegmatite	Number of channel samples	Weighted average Ta_2O_5 grade (ppm) for all channel samples
E1	10	648
E2	34	614
E3	22	447
E4	12	768
E5	34	672
E6	21	505
E7	27	579
E8	8	604

These pegmatites on average strike 013° and dip 17° to the SW (PC_4), and range between 10 cm – 3.5 m in thickness. They are laterally continuous and consistently thin towards the extreme NE, and the extreme SW, with the central portions being the thickest. They are gently and openly folded (PCF_4) with fold axes trending NW-SE. Rarely these pegmatites are slightly offset by late-stage normal faults (NFC).

These pegmatites are largely texturally homogenous and similar in texture and composition to the F1 pegmatite; however, they are more enriched in lithium. They contain cm-scale ribbony and banded textures defined by concentrations of quartz, sugary albite, minor perthitic feldspar, zinnwaldite and trace amounts of spodumene, lepidolite and fluorite. Spodumene and lepidolite contents increase uphill and towards the west (e.g., Young et al., 1981; this study) and are generally enriched towards the hanging wall contacts of the pegmatites. The E3 pegmatite is the only pegmatite which clearly

exhibits a well-defined quartz core, although it pinches and swells along strike. Fine-grained microlite and tantalite are disseminated throughout all the pegmatites and are strongly associated with sugary albite.

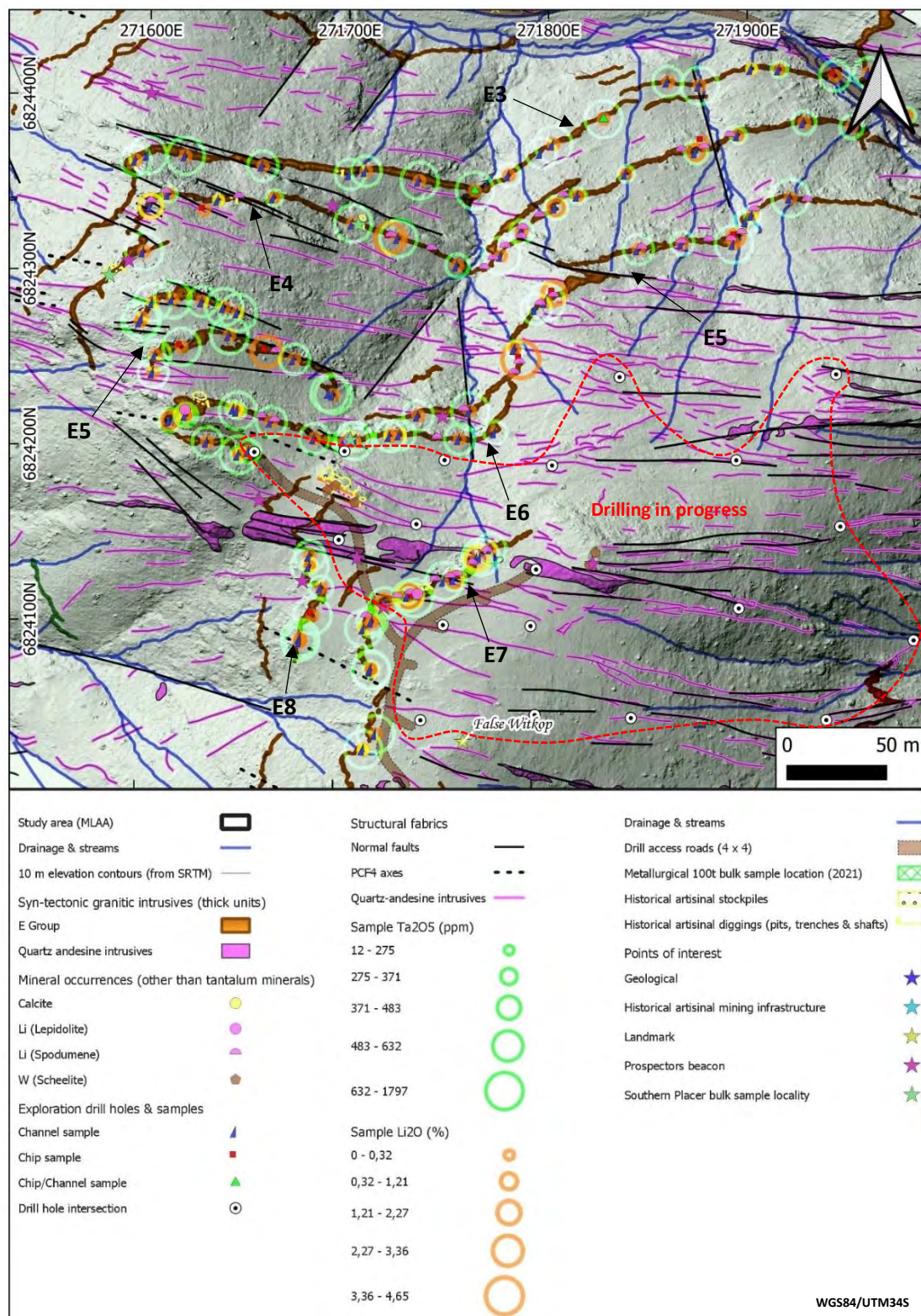


Figure 82: Overview map of the E pegmatite cluster and all the exploration channel samples and their results. There are large areas which are currently being drilled with the aim of intersecting up-dip extensions of the F1 pegmatite.

5.3.3 The D0, D1 and D2 pegmatites

The D0, D1 and D2 pegmatites are the north-western most pegmatites of the Swanson Tantalum Deposit (figure 83). The D2 pegmatite is situated at the bottom, while the D0 pegmatite is situated at the top. These pegmatites are interconnected bifurcate around country rock middlings and could potentially be a larger bifurcated pegmatite body.

On average the D0 – D2 pegmatites (PC₄) strike 017° and dip 14° towards the SW, with individual bodies attaining thicknesses ranging between 1.5 – 9.5 m. In areas where the country rock middlings are not prominent the total pegmatite package attains a thickness of more than 11 m. These pegmatites are bound by a large mylonite zone to the immediate northeast, where the HMG and porphyroclastic granodiorite of the Kinderzitt Granodiorite are in contact. The pegmatites do not transgress this mylonite zone and thin and be deflected upwards towards it. A weakly developed NW-SE trending normal fault set (NFC) crosscuts the pegmatites, although displacements are generally not materially significant. These normal fault sets are observed to be reactivated along the contacts of leucogranite dykes. The pegmatites are gently and openly folded (PCF₄) with fold axes trending NW-SE, especially where thinner faces are exposed.

The Mineral Resource outlined for the D0 – D1 pegmatites to date is presented in table 10 and figures 83 - 84. There appears to be “stratigraphic” trend defined by Li₂O enrichment towards the roof contact of the pegmatite package, and Ta₂O₅ enrichments towards the basal contact of the pegmatite package.

Table 10: Mineral Resource outlined for the D0 – D1 pegmatites to date modified from Mullins and Petzer (2021).

Classification	Pegmatite	Mass (kt)	Ta ₂ O ₅ (ppm)	Nb ₂ O ₅ (ppm)	Li ₂ O (%)
Indicated + Inferred	D0	84.3	351	55	0.88
	D1	409.5	356	83	0.45
	D2	494.4	425	81	0.17
	Total tonnage and weighted average grades	988.2	390	80	0.35

The D0 and D1 pegmatites exhibit prominent internal zoning in places (figure 85). However, these zones are texturally complex and are not obvious in outcrop. They appear to comprise a central layer of viz. 65 – 75 % perthitic feldspar, 25 % quartz, 5 % zinnwaldite with trace amounts of apatite, fluorite, spessartine garnet, microlite and tantalite dispersed throughout, and border layers of viz. 65 % sugary albite, 20 % quartz, 10% zinnwaldite and 5 % spodumene. The border layer nearer to the hanging wall contact generally appears to be more volumetrically prominent than the border layer nearer to the footwall contact (e.g., Young et al., 1981; this study).

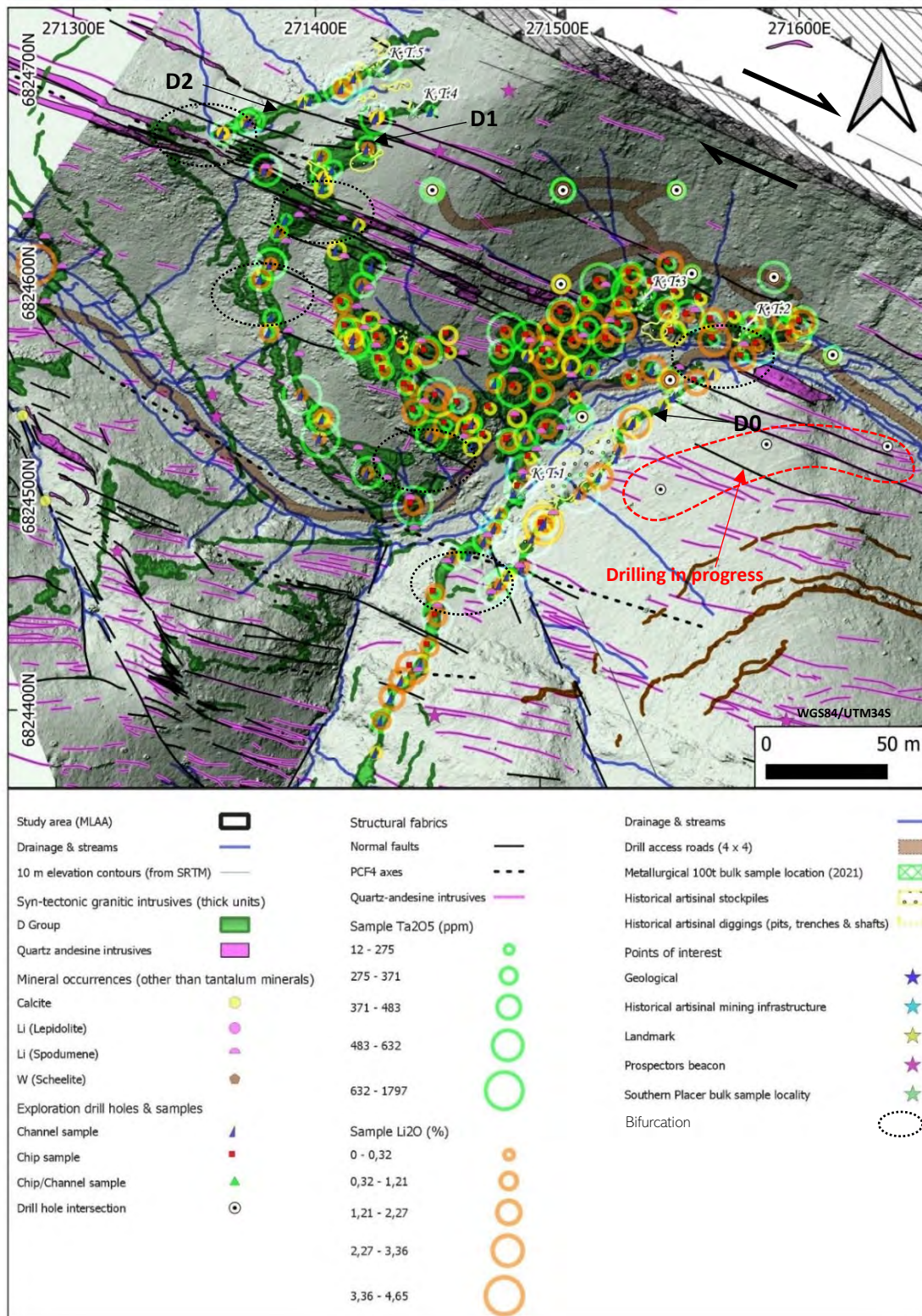


Figure 83: Overview map of the D pegmatite cluster and all the exploration channel samples and results as used in the Mineral Resource Estimation of Mullins and Petzer (2021). The areas which are currently being drilled are indicated.

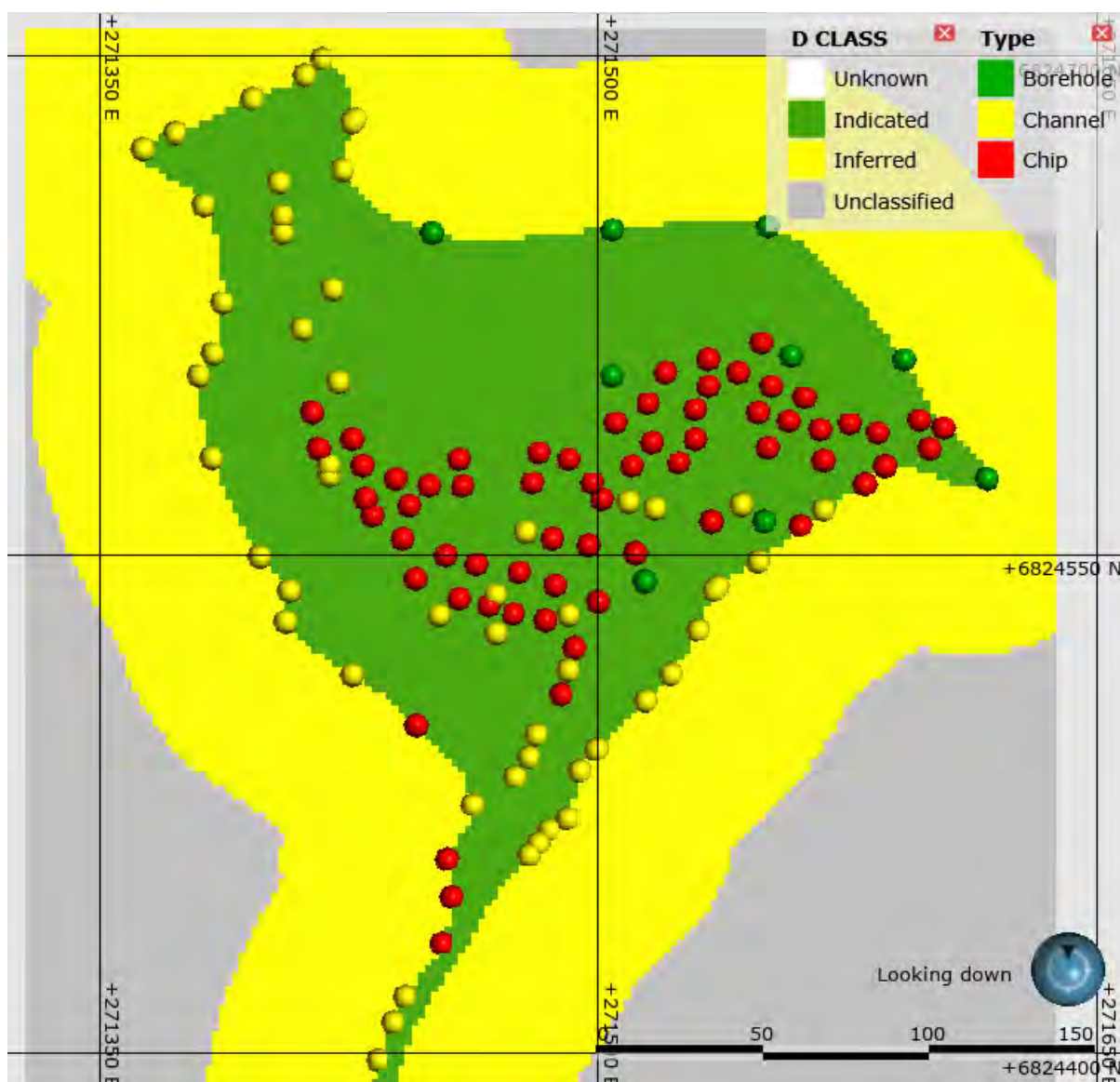


Figure 84: Overview map of the D0 – D2 pegmatites in terms of the Mineral Resource categories. After Mullins and Petzer (2021).

In some places the central layer consists of 0.5 – 1 m in diameter ovoid perthitic feldspar crystals wrapped in quartz and zinnwaldite, with sugary albite and fine-grained disseminated microlite and tantalite appearing to represent a late-stage replacement feature. Additionally, the border layers in some portions of these pegmatites also appear to be devoid of spodumene and are characteristically “spotted” with blebby and rodded quartz in a fine-grained and massive sugary albite matrix. Within such portions a ribbony texture defined by bands of segregated zinnwaldite and/or sugary albitite, and to a lesser extent by quartz, may be present. Mm-scale fine-grained disseminated tantalite and microlite are found throughout all the layers observed, however are mostly associated with the central layer and with high concentrations of sugary albite.

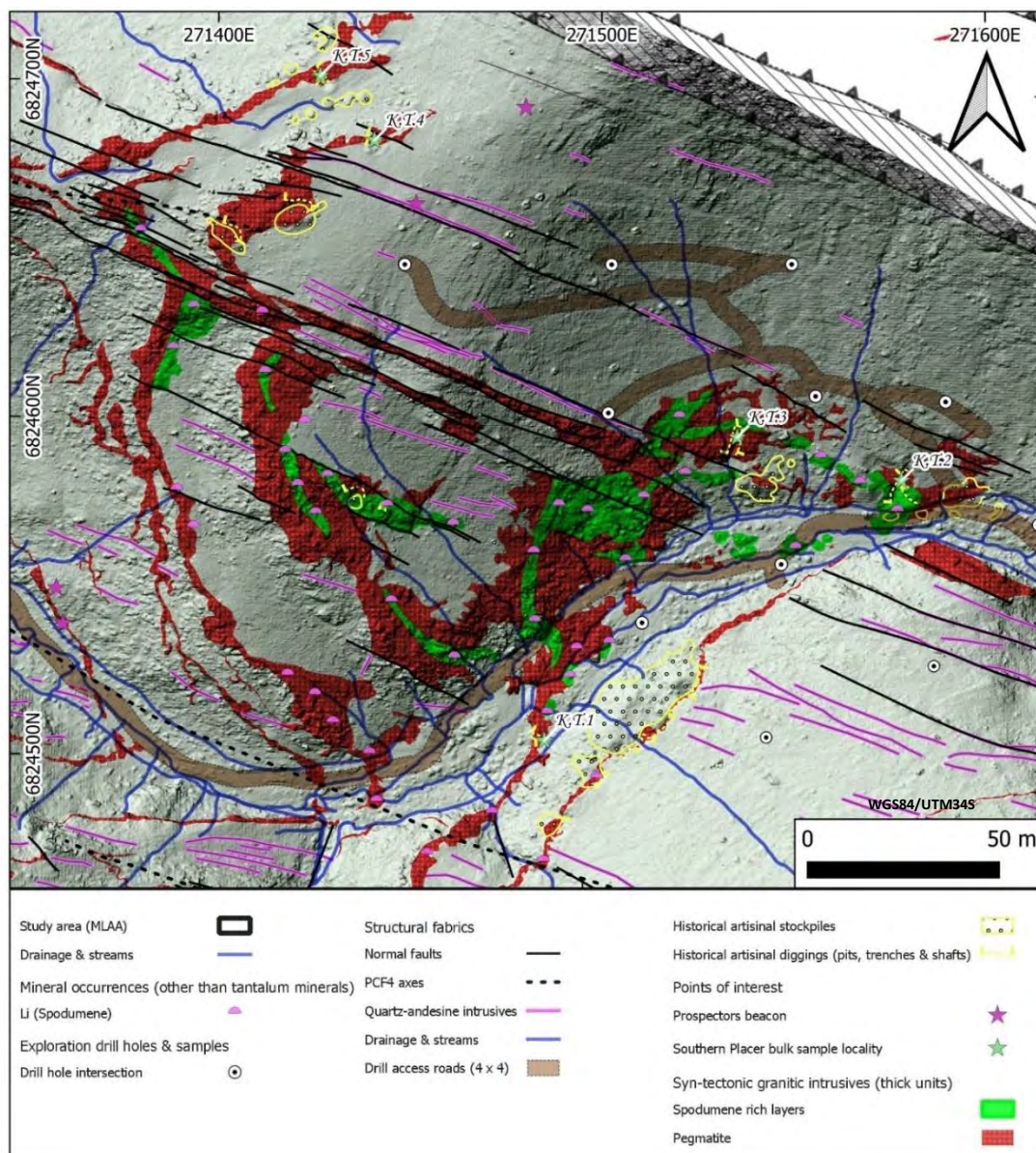


Figure 85: Overview of the D0 – D2 pegmatites indicating the mapped distribution of prominent spodumene enriched layers.

The distribution of the most prominent spodumene enriched layers in the D0 and D1 pegmatites is presented in figure 85. The spodumene crystals, which range between 2 – 20 cm in length, typically exhibit a unidirectional crystallization texture with laths being elongated perpendicular to the pegmatite contacts. Locally these layers may attain spodumene concentrations of viz. > 30 %. ORP is currently of the opinion that spodumene recovery within the Swanson Tantalum Deposit could be realistically realised only for the D0 and D1 pegmatites.

The univariate statistics for all the datapoints used in the MRE by Mullins and Petzer (2021) for the D0 – D2 pegmatites is presented in figures 86. The results for the D0 and D1 pegmatites where combined.

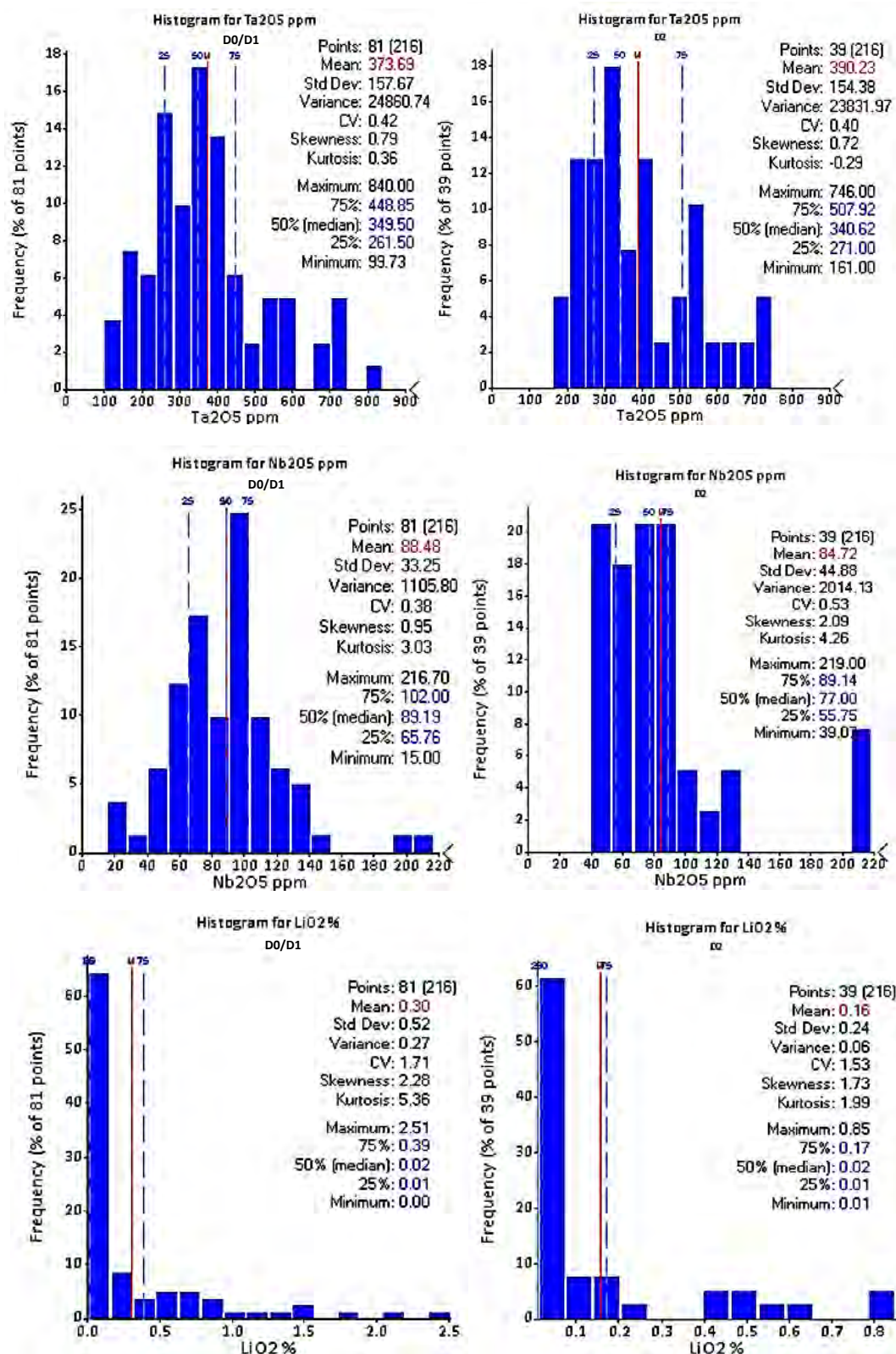


Figure 86: Univariate statistics for Ta₂O₅, Nb₂O₅ and Li₂O grades for all data points used in the Mineral Resource Estimation for the D0 – D2 pegmatites. Modified after Mullins and Petzer (2021).

5.4 Geostatistical robustness and trends in tantalum tenor

A significant characteristic of the Swanson Tantalum Deposit which was identified through the MRE work by Mullins and Petzer (2021) is its apparent geostatistical “robustness”. This refers to the fact that the MRE was successfully able to outline Indicated Resources and robust geostatistical trends based on variographic and univariate statistical analyses of all exploration samples. It was shown that the variograms for the tested pegmatites retain omni-directional *sills* between 0.05 - 0.45, *ranges* between 30 – 50 m, and *nugget effects* between 0.33 – 0.60, and that Ta₂O₅, Nb₂O₅ and Li₂O₅ grades for all the datapoints used in the MRE generally show a normal frequency distribution with little statistical skewing. The statistical character of the pegmatites suggests that their geological and grade continuity can be modelled with relatively high confidence (Mullins and Petzer, 2021).

It is suggested that this apparent geostatistical robustness of the tested pegmatites can be attributed to the high concentrations of fine-grained, massive, and relatively evenly distributed sugary albite, associated fine-grained and disseminated microlite and tantalite, and overall lack of prominently developed internal zonation.

This geostatistical robustness is advantageous. it allows for better predictability in bulk mining as well as a higher confidence in the Mineral Resource. It shows that the sample sizes used in the MRE are sufficient, which is usually not the case for pegmatite hosted deposits in general (Scogings et al., 2016). Typically, pegmatite hosted deposits require impractically large sample sizes before their geostatistical variance can be accurately constrained and predicted (e.g., Gy, 1993). The geostatistical variance within a pegmatite hosted Mineral Resource is usually more difficult to constrain if prominent zonation is present within the pegmatite(s) (Scogings et al., 2016).

A prominent geostatistical trend also outlined for the Swanson Tantalum Deposit by Mullins and Petzer (2021) and by Young et al. (1981) is a general increase in Ta₂O₅ grade of the pegmatites from the NW towards the SE, in the direction towards the TVC proper (figures 87 - 88). Young et al. (1981) also showed that the Ta₂O₅:Nb₂O₅ ratio consistently increases from the NW towards the SE, with their reported ratios being 2.81 for the C pegmatite cluster, 3.65 for the D pegmatite cluster, 8.50 for E pegmatite cluster and 8.42 for the F1 pegmatite. The similarity in the Ta₂O₅:Nb₂O₅ ratio for the E pegmatite cluster and the F1 pegmatite suggests that it is directly correlated to the E pegmatite cluster.

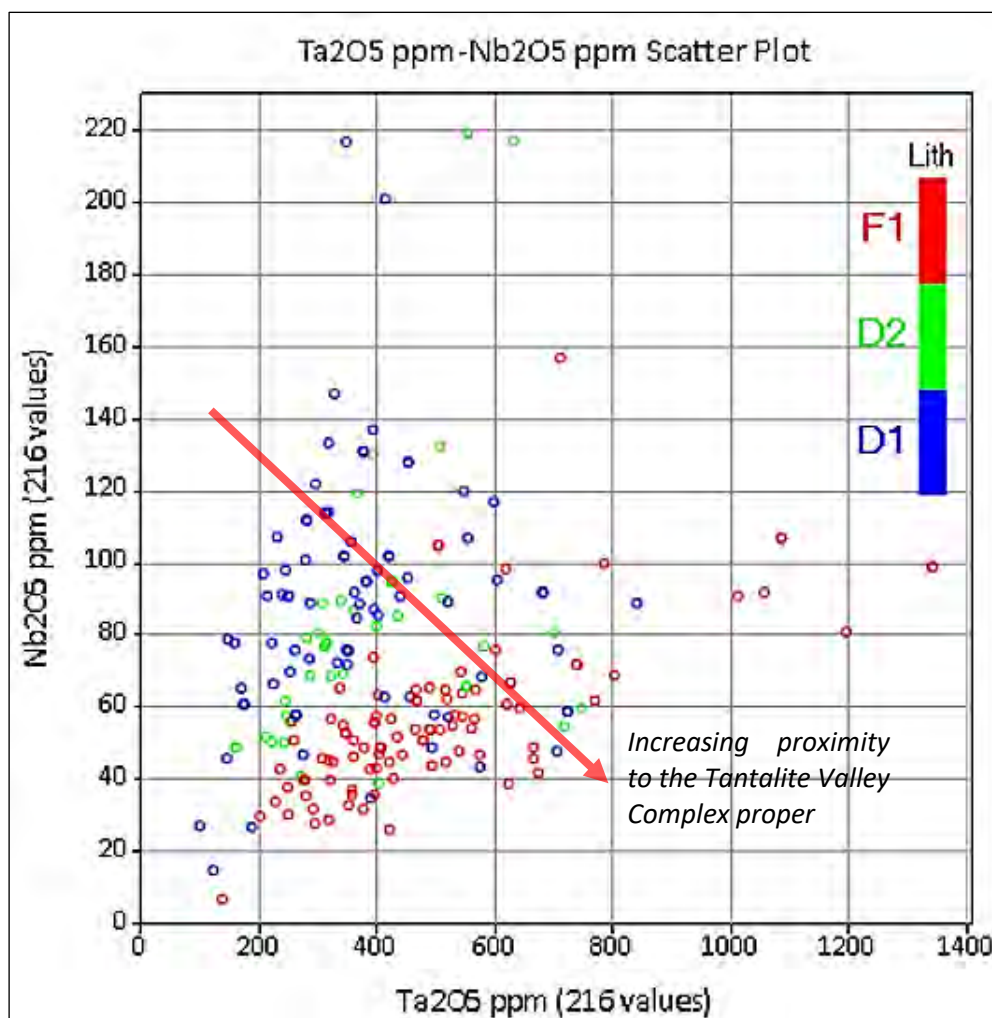


Figure 87: Ta₂O₅ vs. Nb₂O₅ plot of all data points used in Resource Estimation of the D1/D0, D2 and F1 pegmatites indicating a clear geochemical trend defined by Ta₂O₅ tenor and Ta₂O₅:Nb₂O₅ ratios with proximity to the Tantalite Valley Complex proper. After Mullins and Petzer (2021).

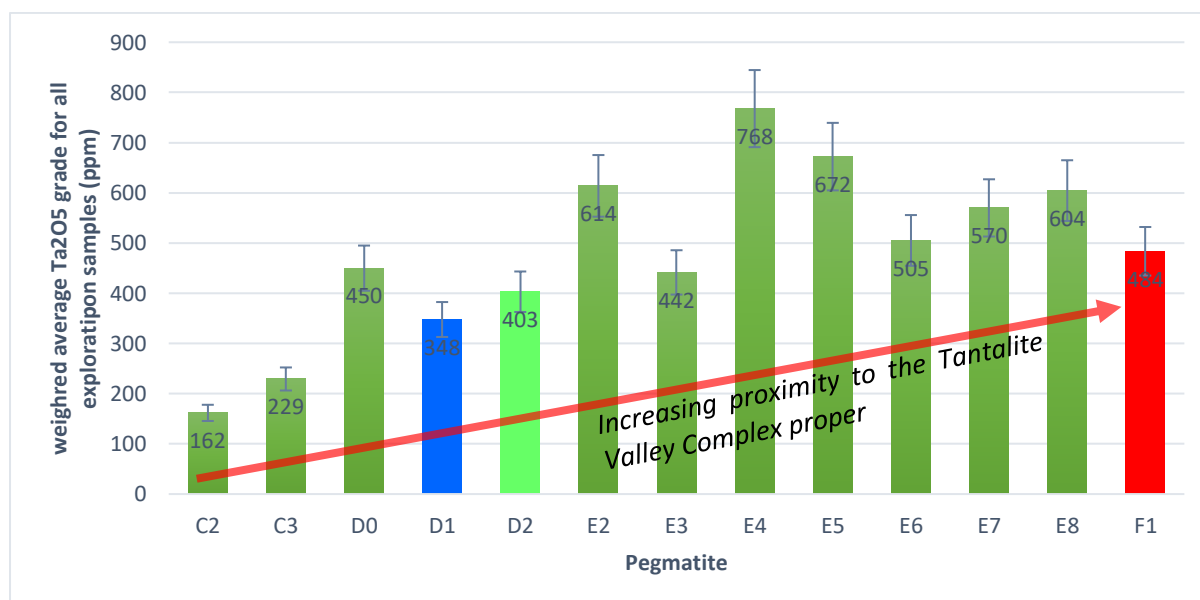


Figure 88: Weighted average Ta₂O₅ grades of pegmatites of economic interest comprising the Swanson Tantalum Deposit arranged by proximity to the Tantalite Valley Complex proper.

5.5 Mineralogical characterization, beneficiation, and recovery of tantalum minerals

Only high-level investigation into the mineralogical characterisation, beneficiation, and recovery of tantalum minerals has been conducted to date. It was based on a 5.5-ton composite bulk sample of the F1 pegmatite with a ca. head grade of 449 ppm Ta_2O_5 and 35 ppm Nb_2O_5 and density of 2.66 ton/m^3 (Bezuidenhout et al., 2020; Ilunga et al., 2020). The Ta_2O_5 and Nb_2O_5 grade of this sample is comparable to the average grade of the current Mineral Resource (412 ppm Ta_2O_5 and 76 ppm Nb_2O_5). Li_2O , associated with spodumene, lepidolite and zinnwaldite, was not materially present within this sample and was subsequently omitted in its investigation. Therefore, the focus was on tantalum-bearing minerals only.

This third-party mineralogical characterization of the 5.5-ton bulk sample was done in two stages. The first stage investigated the pre-enhanced raw material, and the second investigated heavy mineral concentrates produced through particle liberation and enhancement by Multi-Gravity Separator (MGS) spiral and magnetic methods. Both stages were subject to petrographic (thin section), X-ray Diffraction (XRD), Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), Particle Size Distribution (PSD) and Quantitative Evaluation of Minerals by Scanning Electron Microscopy (QEMSCAN) analyses. This work was not aimed at producing a tantalum concentrate, but rather at understanding the nature of the tantalum and associated minerals present within the sample. However, a general and preliminary minerals processing and beneficiation flow sheet was derived from this work.

Detailed bench-scale test work is currently being conducted on 100-ton composite bulk sample of the F1 pegmatite, although the results are not yet available. This work is aimed at proving a commercially viable process flow sheet capable of producing a 25 % Ta_2O_5 concentrate at 68 % recovery. The content and progress of this body of work is briefly discussed in Chapter 5.5.2.

These investigations to date will only be briefly summarized and should be viewed as being qualitative rather than quantitative.

5.5.1 Mineralogical characterization

The mineral phases identified and their abundances and liberated PSDs within pre-enhanced 5.5-ton bulk sample are presented in table 11. Minerals such as “Fe-oxides”, chlorite, kaolinite, sepiolite, and calcite are assumed to be secondary. Primary mineral phases which were identified in the bulk sample, but were not identified in the field, include cassiterite, columbite, zircon, gahnite, crandallite-goyazite, chromite-magnetite, ilmenite, rutile, montebrasite and tapiolite. These minerals are present in trace and accessory amounts only.

The extracted heavy mineral concentrates modally represent approximately 6 % of the bulk sample (figure 89), with the remainder being comprised primarily of feldspar (predominantly albite), quartz and zinnwaldite. Of this 6 % approximately 50 % is represented by spessartine garnet and 10 % by Ta and Sn bearing mineral phases, primarily microlite, tantalite, cassiterite and tapiolite. Apatite also occurs in significant quantities in the heavy mineral concentrate (Bezuidenhout et al., 2020; Ilunga et al., 2020).

Table 11: Mineral phases identified and their liberated particle size distribution within the pre-enhanced bulk sample as per QEMSCAN and XRD analyses. The PSDs of feldspar and quartz are artificial as they are generally coarser grained, while the PSDs of the remainder of the minerals are likely more realistic as they are generally finer grained. Modified from Bezuidenhout et al. (2020) and Ilunga et al. (2020).

Mineral phase	Total (%)	PSD: <300 μm />180 μm (%)	% PSD: <180 μm />45 μm (%)	% PSD: <45 μm />0 μm (%)
Plagioclase (albite)	58.32	61.51	57.37	57.89
Quartz	31.5	28.12	33.97	28.61
Mica (zinnwaldite, lepidolite, minor biotite)	7.97	8.58	6.88	9.97
K-feldspar	0.99	0.89	0.9	1.28
Spessartine	0.42	0.44	0.38	0.49
Cassiterite	0.12	0.13	0.11	0.16
Apatite	0.11	0.07	0.09	0.19
Fe-oxides	0.1	0.01	0.03	0.35
Chlorite	0.09	0.06	0.08	0.12
Kaolinite/Sepiolite	0.07	0.03	0.05	0.17
Tantalite-Microlite (Fe, Mn)	0.07	0.05	0.04	0.16
Fe (Mn)-metal	0.05	0.02	0.02	0.13
Zircon	0.05	0.01	0	0.23
Calcite	0.05	0.02	0.03	0.1
Crandallite-Goyazite	0.03	0.02	0.03	0.06
Chromite-Magnetite	0.02	0	0.02	0.03
Ilmenite/Rutile	0.01	0.04	0.01	0
Montebrasite	0.01	0	0	0.02
Tapiolite-Fe	0.01	0	0	0.03
Total	100	100	100	100

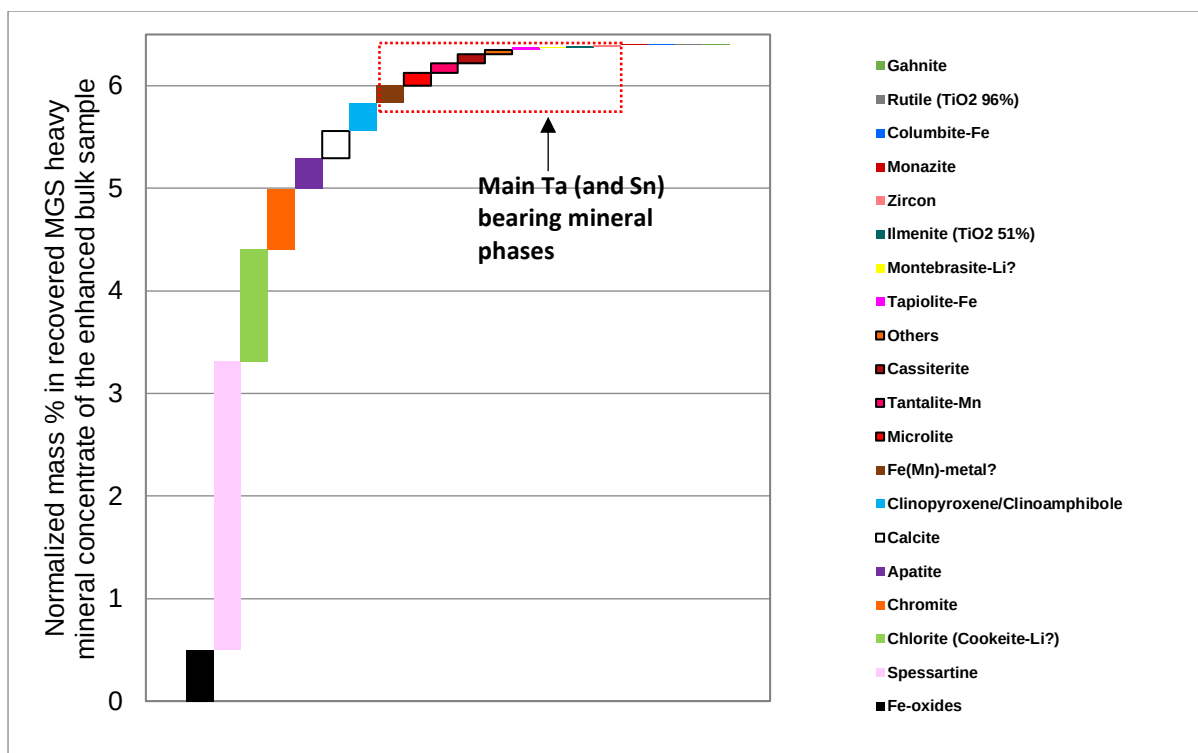


Figure 89: Cumulative modal composition of the 6 % heavy mineral concentrate extracted from the 5.5-ton bulk sample. Note that spessartine garnet dominates the recovered heavy mineral assemblage. Modified from Bezuidenhout et al. (2020) and Ilunga et al. (2020).

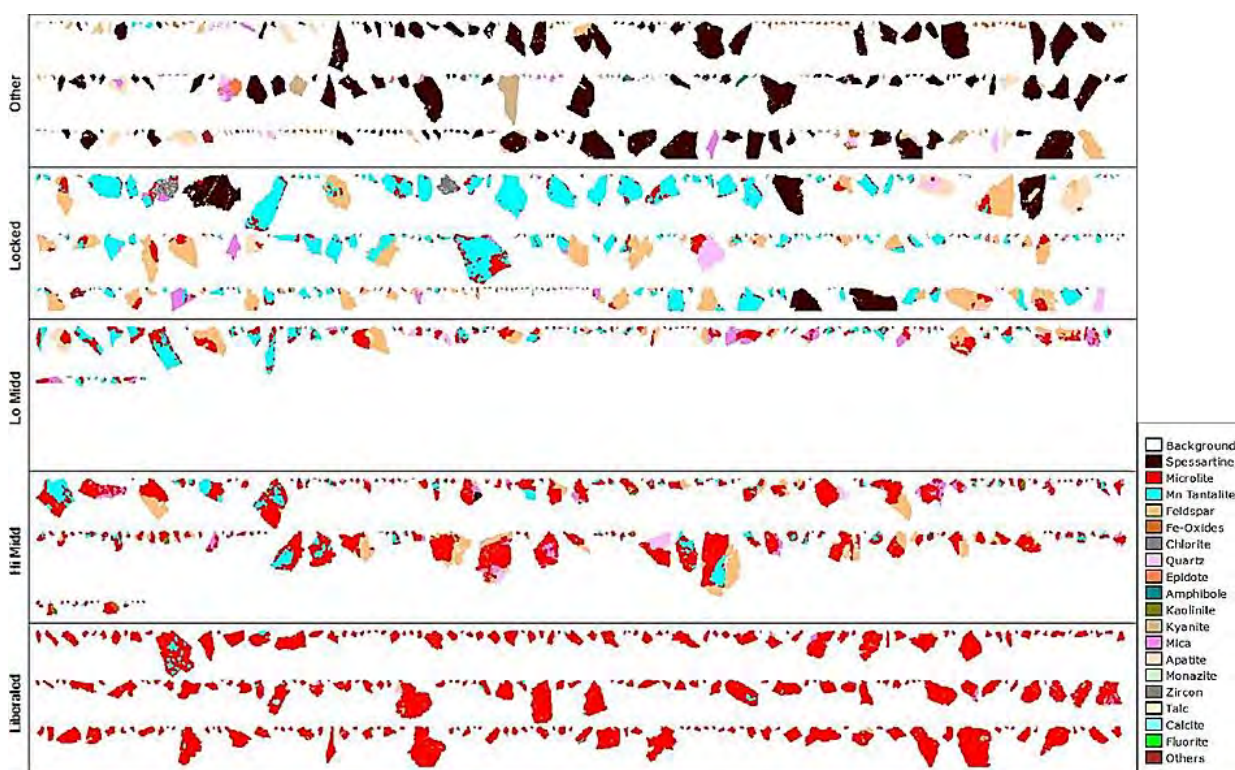


Figure 90: QEMSCAN analyses of the < 300 μm fraction of the heavy mineral concentrate recovered from the 5.5-ton bulk sample. It clearly shows that microlite is more prevalent than tantalite, and that the one is exsolved from the other. Modified from Bezuidenhout et al. (2020) and Ilunga et al. (2020). Other: liberated grains with <95% microlite; Locked: liberated grains with > 10 % microlite; Lo-Midd: Liberated grains with > 30 % microlite s; Hi-Midd: Liberated grains with >50% microlite; Liberated: Liberated grains with >90% microlite.

Most of the tantalum within the retrieved concentrate appeared to be hosted in microlite, with microlite also being significantly more prevalent than tantalite (e.g., figure 90). Minor tapiolite and grains of intergrown cassiterite-tapio-tantalite occur in accessory amounts (Bezuidenhout et al., 2020; Ilunga et al., 2020). In the QEMSCAN image in figure 90 and in the SEM images in figures 91, it is evident that microlite and tantalite exhibit exsolution texture, and that they are also in close association with feldspar (albite).

Bezuidenhout et al. (2020) showed that up to 80% of the tantalum minerals are fully liberated in the < 300 µm size fraction, and that up to 20 % of the tantalum minerals are only liberated in the < 45 µm size fraction. This suggests that there are possibly two size fraction populations of tantalum minerals, and that tantalum mineralisation is very fine-grained overall. This substantiates the field observations in Chapter 4.3.4.2.2.

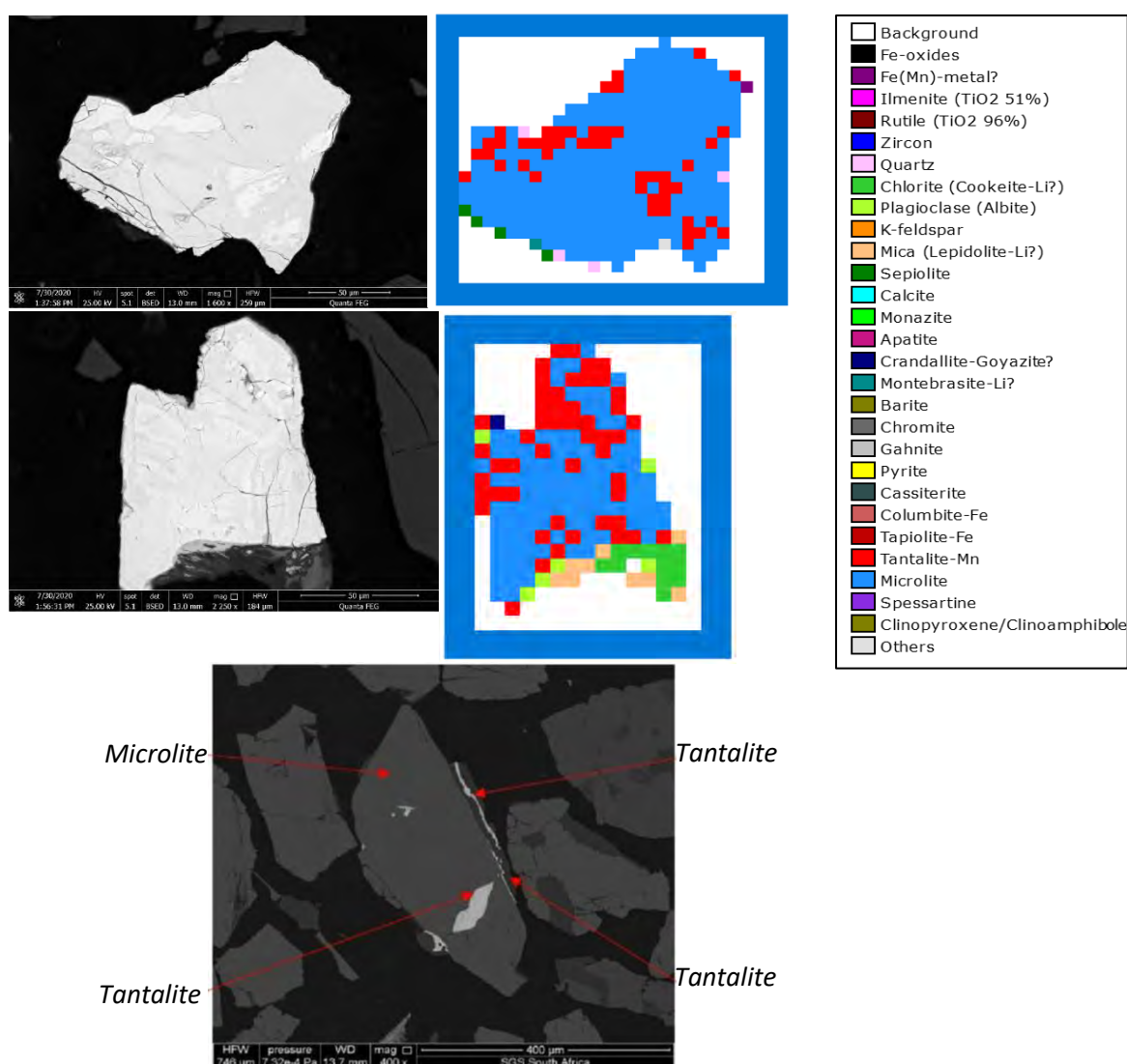


Figure 91: SEM images of some of the liberated tantalum minerals. The predominant mineral is clearly seen to be microlite with exsolutions of tantalite. Modified from Bezuidenhout et al. (2020) and Ilunga et al. (2020).

5.5.2 Tantalum beneficiation and recovery

ORP is currently undertaking rigorous metallurgical and bench-scale beneficiation and recovery test work on the 100-ton bulk sample. The high density of the tantalum minerals and tantalum bearing particles, varying between 5 - 8 g/cm³, allows for cheaper density-based recovery processes (Le Roux et al., 2020). Consequently, this work focusses on a multistage, magnetic enhanced dense media- and gravity separator approach (e.g., Ilunga et al., 2021). Current testing is aimed at designing a detailed process flow sheet capable of producing a saleable 25 % Ta₂O₅ concentrate at a recovery of 68% on a commercial scale (Ilunga et al., 2021). This work forms part of a planned Feasibility Study and is intended for the conversion of current Mineral Resources into Mineral Reserves. The current general circuit being investigated comprises:

- (1) The reduction of feed material to <1.0 mm by means of crushers and a Vertical Shaft Impactor (VSI)
- (2) A multi-unit spiral circuit consisting of rougher, scavenger and cleaner spirals
- (3) Wet milling of the spiral concentrate to <150 µm in order to liberate finer grained tantalum minerals
- (4) Recovery of fine tantalum minerals by means of a multi-unit MGS process

Issues relating to magnetic enhancement of the produced tantalum mineral concentrates are being investigated. For example, tantalite and microlite in many instances exhibit exsolution texture, but only one is susceptible to magnetic separation - tantalite. This means that only liberated particles which are dominated by tantalite can be effectively magnetically extracted. Also, spessartine garnet, which occurs in high percentages within the recovered tantalum mineral concentrates, is also highly magnetically susceptible. Subsequently, tantalite and spessartine garnet, and microlite, can potentially be magnetically separated into different circuits. The primary issue in this regard is the dilution within produced concentrates of Ta₂O₅ by excessive spessartine garnet due to ineffective separation between tantalite and spessartine garnet. The current test work is likely to resolve this issue, as well as to focus on the recovery of Ta₂O₅ from the ultrafines fraction (<45 µm) (e.g., Ilunga et al., 2021).

5.6 Gold equivalent of the Mineral Resource

A crude gold equivalent for the current Mineral Resource is estimated here. This estimation is not economically robust and should be taken as a guideline only. Its primary intent is to present the Mineral Resource in approximate *grade-tonnage* terms which are more relatable and conventional to mining industry investors. It considers tantalum as being the only valuable commodity, and therefore excludes any potential value which could be added from Li_2O and Nb_2O_5 . It is only valid at *present* (Q4 2021) and is subject to change mainly depending on commodity prices and mineral beneficiation recoveries.

5.6.1 Calculation of the Au-equivalent

Assuming an overall recovery of 68 % a total of 338 293 kg of recoverable and saleable Ta_2O_5 can be estimated to be present within the current Mineral Resource (1.2 Mt @ 412 ppm Ta_2O_5). An average spot price for a 100 % Ta_2O_5 concentrate (CIF China) between the periods of 05 – 2020 and 08 – 2021, adjusted with exchange rates, could be estimated at 2327.35 R/kg (figure 93). An average spot price for a 25 % Ta_2O_5 concentrate (CIF China) for the same period, adjusted with exchange rates, is estimated at 581.84 R/kg (figure 92). These average spot prices do not account for inflation due to the period investigated being less than 1 year. An average *current* spot price of 581.84 R/kg will be used here on the premise that ORP is presently aiming at producing a commercially viable 25 % Ta_2O_5 concentrate.

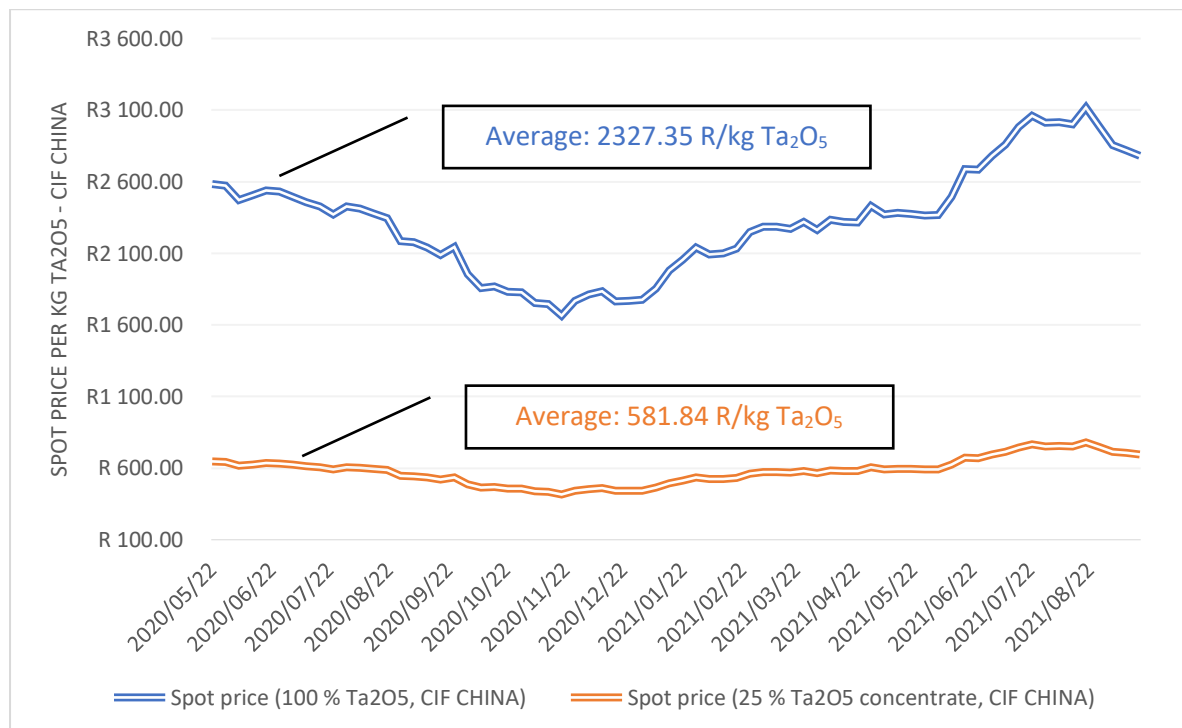


Figure 92: Spot prices for Ta_2O_5 concentrates. Sources: <http://www.asianmetal.com/TantalumPrice/Tantalum.html> and <https://www.argusmedia.com/metals-platform/price/assessment/tantalite-basis-30-ta2o5-cif-main-port-PA00143570000>.

The perceived *in-situ* and *current* value of the recoverable and saleable 25 % Ta₂O₅ concentrate contained within the current Mineral Resource, as based on the average spot price of 581.84 R/kg, is thus estimated to be R 196 832 399. The conversion of 338 293 kg of perceived recoverable and saleable Ta₂O₅ into troy ounces (using 31.01 g/troy ounce) yields 10 876 373 troy ounces. Thus, the *in-situ* and *current* value of the perceived recoverable and saleable 25 % Ta₂O₅ concentrate is 18.1 R/troy ounce (e.g., R 196 832 399 divided by 10 876 373 troy ounces).

The average spot price for gold for the same period, adjusted with exchange rates, could be estimated at 26 265.49 R/troy ounce. This average spot price does not account for inflation due to the spot price period investigated being less than 1 year.

Thus, 1 troy ounce of gold is *currently* 1451 times more valuable than 1 troy ounce of perceived saleable and recoverable Ta₂O₅ present within the current Mineral Resource. By applying this ratio, an equivalent in gold troy ounces can be calculated for the Ta₂O₅ Mineral Resource (e.g., R 196 832 399 divided by 1451). This yields an equivalent of 135 641 (135.6 k toz) troy ounces, or 4 218 907g of gold (using 31.01 g/troy ounce).

By dividing the gold equivalent of 4 218 907g into the originally estimated tonnage of the Ta₂O₅ Mineral Resource (i.e., 1.2 Mt), the gold equivalent grade of the Mineral Resource, at an assumed overall recovery of 68 %, is estimated to be **3.51 g/ton Au**.

A very generalized comparison between the tantalum and gold equivalent Mineral Resource is given in table 12.

Table 12: General comparison between the current tantalum and gold equivalent Mineral Resources showing that in gold equivalent terms the Swanson Tantalum Deposit can currently be considered as an attractive deposit worthy of further development.

	Tantalum Mineral Resource	Gold equivalent Mineral Resource
Size/tonnage	1.2 Mt	135.6 koz Au
Average grade	412 ppm Ta ₂ O ₅	3.51 g/ton Au
General mineability	Amenable to opencast mining operations and simple density-based recovery processes (overall 68 % recovery)	Opencast mining operations and simple density-based recovery processes comparable to “free-milling” gold mining of placer-type deposits

6 Discussion

6.1 Structural control on pegmatite emplacement and tantalum tenor

It is evident that the emplacement, orientation, and tantalum tenor of the pegmatites within the study area is structurally controlled, i.e., pegmatites occurring within the HMG and/or the TVC proper are significantly mineralised, laterally continuous, and shallow dipping, while pegmatites occurring outside of it are steeply dipping, partially mylonitised and barren.

At least three main factors were identified which influence the emplacement, geometry, and tantalum tenor of the mineralised pegmatites. These are (1) the competency and relative strain of the host rocks, (2) the strain shadow effect of the Tantalite Valley Complex proper, and (3) proximity to the Tantalite Valley Complex proper. These factors are directly related to the local kinematics of the MRPSZ.

The TVC proper represents a mega-scale competent mantle-porphyroclast (the TVC-megaclast) within the core zone of the MRPSZ (figure 93). Subsequently extensional lower strain quadrants have developed towards its north-western and south-eastern contacts (e.g., Passchier and Simpson, 1986; Toogood, 1976). These extensional quadrants, which effectively are strain shadows (e.g., Toogood, 1976), have acted as a locus for syn-tectonic melt emplacement and associated pegmatite hosted tantalum mineralisation. This strain shadow effect is exemplified by the varying frequency, volume, distribution, and orientation of the syn-tectonic leucogranites and shallow dipping pegmatites, the aspect ratio of the HMG, and the progressive increase in tantalum tenor of mineralised pegmatites towards the TVC proper.

It is likely that the structural controls on the emplacement of the mineralised pegmatites within the HMG involve the development of Riedel shears within a relatively competent host rock, while also being locally influenced by the strain-shadow effect of the TVC-megaclast (figure 93). This mode of pegmatite emplacement has been well documented within the MRPSZ (e.g., Lambert, 2013). The overall orientations and relationships to host rock of the pegmatites potentially support this hypothesis (e.g., figure 93).

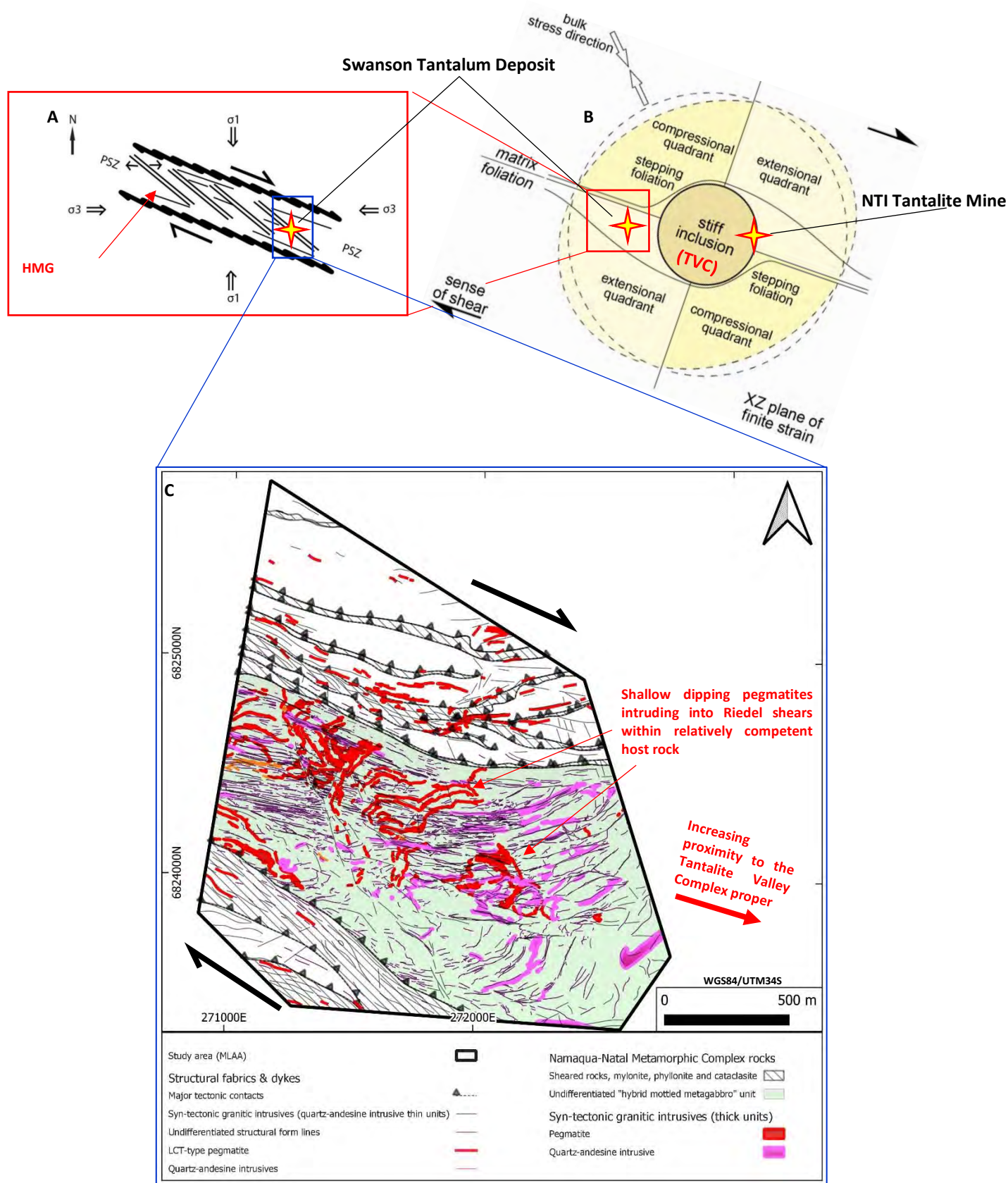


Figure 93: Schematic representation of the various structural controls on the frequency, volume, distribution, and orientation of the syn-tectonic melts (quartz-andesine intrusives, HMG and pegmatites) and associated tantalum mineralisation in the context of the TVC within the MRPSZ. **A** – Riedel shear model for pegmatites intruding into competent host rocks modified after Lambert (2013). **B** – typical strain quadrants which develop around mantle porphyroclasts modified after Passchier and Simpson (1986). **C** – Map of syn-tectonic melts within the study area

6.2 Succession of syn-D₄ melts

There are at least two, possibly three, syn-D₄ melts occurring within the study area. These are from oldest to youngest (1) the HMG, (2) the leucogranite intrusives and (3) the pegmatites of the ORPB and the Swanson Tantalum Deposit. The leucogranites and pegmatites are confirmed to be syn-D₄ in age. The HMG is not presently confirmed to be syn-D₄ or syn-D₂ in age, as there is no representative geochronological or petrographic data currently available for these rocks. Due to its spatial association with the TVC proper and presumably also due to its mafic-dominant appearance the HMG has been assumed to belong to the D₂ Kum Kum Suite and to be a part of the TVC proper, and thus to date to ~ 1212 Ma (e.g., Kartun, 1979; Macey et al., 2015; Moore, 1975). In addition, the leucocratic melts which are mixed with the melanocratic melts of HMG have also been assumed to belong to the Eendoorn Suite, and thus that these melts are comagmatic (Macey et al., 2015). However, field relationships within the study area highlight that these assumptions may not necessarily be correct and that further detailed investigation is required to accurately constrain the relationship of the HMG with the D₂ Kum Kum Suite, the TVC proper and the D₄ MRPSZ. Such field relationships include:

- (1) steeply dipping syn-D₄ dykes of viz. HMG intruding along S₄ foliations within the TVC proper as well as within sheared Kinderzitt Granodiorite,
- (2) xenoliths containing older foliations of coarse-grained gabbroic material which closely resemble rocks from the TVC proper being present within the HMG,
- (3) Possible syn-magmatic fabrics within the HMG which appear to be sub-parallel to S₄ (e.g., Chapter 4.4.6). In addition, the average aspect ratio of the HMG as an entity falls significantly below the average aspect ratio of the higher strain enclaves, and even well below the average aspect ratio of the lower strain enclaves (figure 74). This suggests that the HMG possibly represents a syn-tectonic intrusion which is magmatically elongated within the core zone of the MRPSZ, and that the elongated aspect ratio of the body is not entirely structurally induced,
- (5) the overall finer grain size of the HMG as compared to the coarser and layered textures of the Tantalite Valley Complex proper,
- (6) and the greater compositional and textural variation of the mixed leucocratic melts within the HMG as compared to the relatively homogenous and massive megacrystic Eendoorn Suite melts.

Additional geochronological work is required to accurately constrain the age of the HMG and its preserved (syn-magmatic?) fabrics. However, in context of the field relationships observed in this study it appears that it may possibly be syn-D₄ in age. The HMG's relationship with the Kum Kum Suite, TVC proper and MRPSZ is still unclear, and it should not be irrevocably assumed to belong to

the D₂ Kum Kum Suite or TVC proper, especially in context of the lack of any geochronological and representative petrographic data.

Besides the brief petrographic description by Von Backström (1976) and their mentioning by Kartun (1979), it is also uncertain what the exact age of the leucogranite (quartz-andesine) intrusions are and which suite they belong to. It is however very clear that they are syn-tectonic with respect to the MRPSZ, are spatially associated with the HMG, are older than the locally occurring pegmatites of the Swanson Tantalum Deposit and are texturally like the granitic segregations observed along the margins of *viz.* HMG dykes.

The only known suite which could potentially be associated to these leucogranites is the Warmbad Granite Suite (e.g., Beukes, 1973; Doggart, 2019; Macey et al., 2015, 2017). This potential association is based principally on textural grounds, and not on geochronological or geochemical grounds. The Warmbad Granite Suite comprises fine to medium-grained equigranular biotite-muscovite leucogranite and has been mapped as numerous discordant dykes and as small plutons within the study area surrounds (Beukes, 1973; Doggart, 2019; Macey et al., 2015, 2017). It has been shown to be late syn-tectonic with respect to the development of the D₄ MRPSZ, and to be comagmatic with the pegmatites of the ORPB (Beukes, 1973; Doggart, 2019; Macey et al., 2015, 2017). The evidence which might suggest that the leucogranite intrusives in the study area may not be related to the Warmbad Granite Suite is the fact that in the study area they are distinctly older than pegmatites, and that they are spatially restricted to the HMG and to a lesser extent the TVC proper. The close association of the leucogranite intrusions with older ductile S₄ fabrics places them as early syn-D₄ in age. The fact that all pegmatites in the study area crosscut S₄ and the leucogranite intrusions at high angles, and are associated with shallow angle thrusts, suggests that they are late syn-D₄ in age. This time-dependant strain regime variation does not support such a comagmatic relationship between the pegmatites and leucogranites (as has been shown for pegmatites and the Warmbad Suite outside of the study area, e.g., Beukes, 1973; Doggart, 2019; Macey et al., 2015). The leucogranite intrusives may instead be related to the HMG as they are always found in close spatial and temporal association (e.g., as granitic segregations in *viz.* HMG dykes, and as dykes, sills and plugs predominantly restricted to the HMG), rather than be related to the Warmbad Suite, however this hypothesis requires rigorous investigation to be substantiated.

Considering the field observations presented in this study, and the fact that all these melts occur in close spatial association with one another, as well as being hosted within a common D₄ tectonic structure (i.e., the north-western extensional quadrant/strain shadow of the TVC proper within the MRPSZ), they may all have been emplaced in close temporal succession to one another. If so, they

would have had to cool, solidify, and accommodate strain in relatively quick succession within the context of D₄ kinematics.

6.3 Prevailing stress regimes and strain responses

The rock types occurring within the study area are diverse and clearly have different strain responses with respect to D₄ deformation within the MRPSZ. No indication of successively overprinting fabrics (e.g., overprinting of D₂ fabrics by D₄ fabrics, or earlier D₄ fabrics by later D₄ fabrics) occur within the study area. Structural fabrics are rather observed to progressively change in orientation and intensity depending primarily on host lithology, strain intensity and proximity to the TVC proper.

The sub-parallelism of PCF₄, F₄ and L₄, regardless of their host lithology and local orientations, suggests that they formed contemporaneously under a common and prolonged stress regime. It is therefore likely that the geometrical variation in clusters of sub-parallel orientated PCF₄, F₄ and L₄ reflects the variation produced by heterogeneously partitioned coaxial and non-coaxial, and/or transpressional and transtensional strain.

The overall ductile-dominant S₄ fabrics, which includes ductile folding of retrogressed fabrics, and the lack of pervasive brittle-dominant fabrics, suggests that S₄ formed predominantly under elevated P-T conditions (e.g., Fossen et al., 2017). In the study area retrogressed fabrics are always associated with the highest strain zones, particularly within ultramylonite zones and intrafolial pseudotachylite breccias. It is therefore favoured in this study that retrogression is associated with strain rate and strain intensity induced processes (e.g., Cisneros-Lazaro et al., 2019; Diener et al., 2016), and that it is not related to syn-tectonic exhumation of the MRPSZ (e.g., Lambert, 2013; Macey et al., 2014, 2017).

The fact that younger pegmatites of the Swanson Tantalum Deposit utilize shallow thrusts and crosscut earlier S₄ fabrics and associated leucogranite intrusions at high angles suggests that pegmatite emplacement locally post-dates the main ductile phase of deformation, and that it rather intruded during a more brittle-dominant strain regime. The only evidence in the study area for the pegmatites being coeval with S₄ is the sub parallelism of PCF₄ axial planes with S₄, suggesting that PCF₄ is axial planar to S₄, and the sub parallelism of PCF₄ fold hinges with L₄, suggesting that PCF₄ is coeval with L₄. However, PCF₄ is very weakly developed and the relationship between S₄, L₄ and PCF₄ is subtle and not distinct.

6.4 Potential implications of the HMG for the MRPSZ and the Kum Kum Suite

This study highlights that there is a possibility that the HMG may be syn-D₄ in age. It is crosscut by the pegmatites comprising the Swanson Tantalum Deposit and is itself seen to crosscut the Kinderzitt Granodiorite of the Eendoorn Suite and the TVC proper of the Kum Kum Suite. The age reported for

the Kinderzitt Granodiorite is ~ 1190 Ma, and the age reported for the TVC proper is ~ 1212 Ma (Macey et al., 2015). The age for the locally occurring pegmatites has been reported to be ~ 1005 Ma (Doggart, 2019). Therefore, based on crosscutting relationships from this study the age of the HMG may potentially be somewhere between $\sim 1190 - 1005$ Ma, if the assumption that it is syn-D₄ in age is correct. This would implicate it as being unrelated to D₂ and the Kum Kum Suite, and to possibly represent the oldest known but undated syn-D₄ melt within the MRPSZ (e.g., Doggart, 2019; Lambert, 2013; Macey et al., 2015, 2017).

The HMG, pegmatites comprising the Swanson Tantalum Deposit, and associated leucogranite intrusions potentially represent prime geochronological markers with which to date the upper and lower age limits of the MRPSZ within a confined study area. Traditional geochronology of the MRPSZ has focussed primarily on the ORPB, and it might only represent a lower age limit for the MRPSZ.

6.5 Economic outlook of the Swanson Tantalum Deposit

The Mineral Resource of the Swanson Tantalum Deposit benchmarks the deposit as being a relatively “high grade – low tonnage” LCT-type pegmatite hosted tantalum deposit. It can crudely be converted into a *current* gold-equivalent opencast “free-milling” Mineral Resource with an average grade of 3.51 g/ton or 135.6 koz of contained gold, at an overall recovery of 68 %. Based on the current global market conditions the Swanson Tantalum Deposit is highly relevant, especially given the demand in the present-day technology market. Ongoing exploration aims to continue developing the Mineral Resource and outline Mineral Reserves.

Current advantages of the Swanson Tantalum Deposit are (1) its exceptional tantalum grades, (2) geostatistical robustness allowing for relatively predictable bulk mining, (3) amenability to opencast mining operations, and (4) cheap density-based methods for beneficiation and recovery of tantalum minerals. Some disadvantages are (1) the fine-grain size of tantalum minerals which increases processing costs, the high spessartine garnet content and exsolution between tantalite and microlite which make magnetically enhanced recovery and separate processing circuits complicated, (2) relatively low lithium potential, (3) poor access to water for plant-operations, and (4) difficult mountainous terrane.

7 Conclusions

1. The Swanson Tantalum Deposit is a “high-grade low-tonnage” LCT-type pegmatite hosted tantalum deposit which is highly relevant in the present-day technology market. It has only recently been subject to detailed exploration. It is a structurally controlled deposit comprising a shallow dipping sill-and-dyke swarm of at least 15 economically significant mineralised pegmatites. To date a JORC Maiden Mineral Resource of 1.2 Mt (Indicated and Inferred) @ 412 ppm Ta₂O₅, 76 ppm Nb₂O₅ and 0.29 % Li₂O (at an applied cut-off grade of 236 ppm Ta₂O₅ and a minimum thickness of 1 m) over four outcropping LCT-type pegmatites for Swanson Tantalum Deposit has been declared. This Mineral Resource only encompasses pegmatites D0, D1, D2 and F1 (e.g., Mullins and Petzer, 2021). The majority of the Mineral Resource is represented by the D pegmatites. An interesting aspect of the Swanson Tantalum Deposit is a consistent increase in tantalum tenor of pegmatites from the NW towards the SE, in the direction of the TVC proper. The author is not aware that such a localised structural control on tantalum tenor has been described in literature before. This deposit warrants and is still subject to ongoing exploration, with current exploration aimed at outlining a Mineral Reserve (i.e., a feasibility study).
2. The Swanson Tantalum Deposit’s structural setting is controlled by a combination of the strain shadow effect induced by the TVC proper, which acted as mega-scale competent mantle porphyroclast within the core zone of the MRPSZ, and the development of Riedel fractures in competent host rock, and the varying degrees to which strain was accommodated by various lithologies. The NTI Tantalite Mine, which is situated in the southeast strain shadow of the TVC proper, has a comparable setting. Competent host rocks within the context of the MRPSZ, comprising the (mafic-ultramafic dominant) TVC proper and the HMG occurring within the core zone of the MRPSZ, appear to be the dominant factor controlling the location of economically significant LCT-type pegmatite-hosted lithium and tantalum mineralisation in the area.
3. Locally, the strain shadow effect of the TVC-proper represents a regional-scale dilatational quadrant (e.g., Toogood, 1976). This is an area of relatively low strain which has acted as a locus for preferential syn-D₄ melt emplacement. The confirmed syn-D₄ melts are (1) the leucogranite intrusions, and (2) the pegmatites of the Swanson Tantalum Deposit. Based on field relationships the age of the HMG could potentially fall between ~ 1190 – 1005 Ma, implicating the HMG as possibly representing the oldest locally occurring syn-D₄ melt. However, it may be syn-D₂ (e.g., Macey et al., 2015, 2017). If the HMG can be conclusively proven to be syn-D₄ in age, it could potentially implicate that D₄ and D₃ are at least locally

temporally and spatially related, and that D_4 may have initiated during the late stages of D_2 . This hypothesis requires a great deal of detailed geochronological and petrographic study before they can be substantiated.

4. The HMG, leucogranite intrusions (assuming its unrelated to the Warmbad Granite Suite) and the pegmatites comprising the Swanson Tantalum Deposit, present prime geochronological markers with which to potentially refine the upper and lower age limits of the MRPSZ within a confined study area. Geochronology of the MRPSZ has traditionally focussed primarily only on the regionally occurring pegmatites of the ORPB (e.g., Doggart, 2019; Lambert, 2013; Macey et al., 2015, 2017). It is possible that the regional geochronology of the MRPSZ is skewed by dating of pegmatites of only.
5. The emplacement of the pegmatites comprising the Swanson Tantalum Deposit seemingly post-dates the main phases of ductile development of S_4 within the HMG, as they crosscut S_4 and associated leucogranite intrusions at high angles and are associated with later stage shallow dipping thrusts (Riedel structures). However, development of S_4 and emplacement of syn- S_4 pegmatites outside of the HMG continued after the apparent cessation of ductile S_4 development within the HMG. This may suggest that the HMG possibly experienced strain hardening and/or transition into the brittle-dominant regime slightly earlier than the rocks adjacent to it. However, the statistical grouping between L_4 , S_4 , PC_4 and PCF_4 , irrespective of the host strain domain, may alternatively suggest that they are all coeval, and that the cessation of ductile S_4 development within the HMG is likely related to local rheological controls and strain response concurrent with ductile-dominant deformation outside of the HMG and brittle-ductile deformation within it. This question may potentially be resolved by dating of pegmatites within and outside of the HMG, and investigation their age differences. It brings into question how such vastly differing strain regimes can occur in such a confined area within a major crustal-scale structure.
6. From the field observations of this study, it is preferred that bulk shearing within the Swanson Tantalum Deposit area occurred under predominantly elevated P-T ductile conditions (e.g., Cisneros-Lazaro et al., 2019; Diener et al., 2016; Toogood, 1976). Retrogressed and cataclastic fabrics are observed to be contemporaneous with ductile deformation (e.g., Cisneros-Lazaro et al., 2019; Kartun, 1979; Toogood, 1976; this study). Retrogression (*viz.* chlorite-muscovite-epidote), phyllonitization, cataclasis, and rarely intrafolial pseudotachylite brecciation, are restricted to the highest strain ultramylonite zones only (e.g., Angombe, 2016; Indongo, Kartun, 1979; 2017; Lambert, 2013; Macey et al., 2015, 2017; Melosh 2015; Melosh et al., 2014, 2015, 2016, 2018; Toogood, 1976). In this study and based on limited field evidence,

these fabrics are suggested to be strain rate and strain intensity induced fabrics associated with localised fluid incursion (e.g., Diener et al., 2016; Melosh 2015; Melosh et al., 2014, 2015, 2016, 2018), rather than represent fabrics related to progressive syn-tectonic exhumation of the MRPSZ and its country rocks (e.g., Lambert, 2013; Macey et al., 2015, 2017). However, this hypothesis requires a great deal of detailed investigation before it can be substantiated.

7. The variation in structural fabrics observed for the Swanson Tantalum Deposit cannot, at least locally, be explained by successive overprinting related to separate D₄ events as proposed by Lambert (2013) and Macey et al. (2015). Instead, it is preferred that variation in structural fabrics in the study area is controlled by variation in host rock rheology, partitioning of strain intensity and strain rate, and proximity to the TVC proper. In this study it is preferred that variations in structural fabrics arises from the coeval heterogeneous distribution of coaxial- and noncoaxial-, and transtensional- and transpressional strain, as well concurrently overprinting brittle to ductile deformation associated with localised fluid incursion (e.g., Toogood, 1976). Such complex structural relationships are typical for crustal-scale ductile-dominant shear zones (e.g., Fossen et al., 2017).
8. The tantalum mineralisation encountered in the Swanson Tantalum Deposit can be described as comprising an assemblage of predominantly fine-grained (80 % < 300 µm) and disseminated tantalite, microlite, and tapiolite which associated with concentrations of massive sugary albite. The tantalum minerals often exhibit exsolution textures with one another. The tantalum minerals and sugary albite, and to a certain extent lepidolite, spodumene and zinnwaldite, appear to be late stage within the crystallization history of the pegmatites (e.g., Young et al., 1981). The lithium mineralisation encountered in the Swanson Tantalum Deposit comprises highly localised concentrations of spodumene, lepidolite and zinnwaldite, with spodumene being the economically most significant. Lithium mineralisation typically appears to be most concentrated towards the hanging wall contacts, as well as topographically upwards within pegmatite packages. The pegmatites are not prominently internally zoned. The high concentrations of sugary albite and associated fine-grained and disseminated tantalum mineralisation, as well as the general lack in prominent internal zonation, has proven favourable for geostatistical analyses and Mineral Resource Estimation. The geostatistical variance could be estimated so that relatively high confidence in geology and grade was achieved.

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See the Thomas, Cornell, Moore and Jacobs reference: what's with the asterisks??? ...remove

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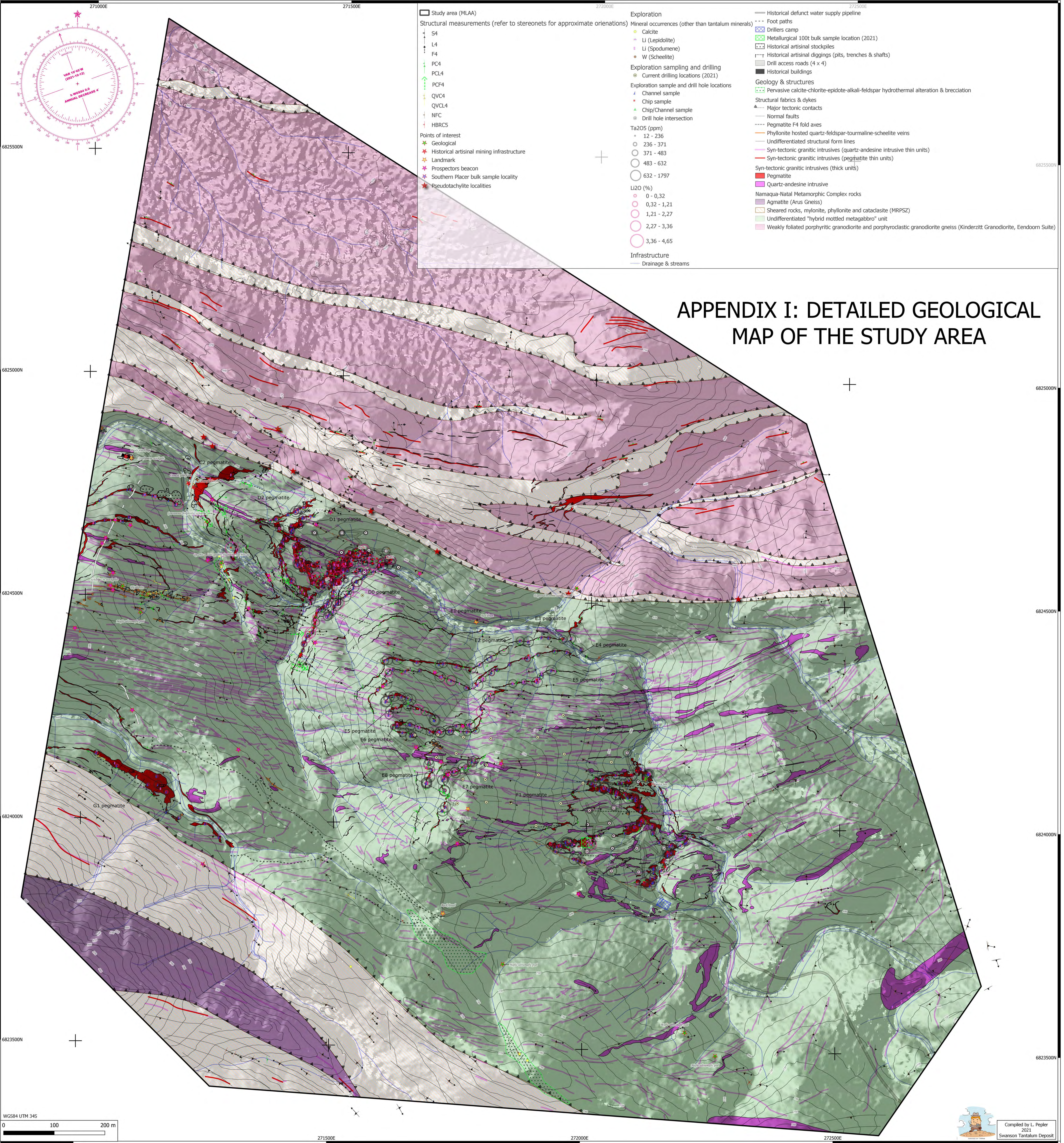
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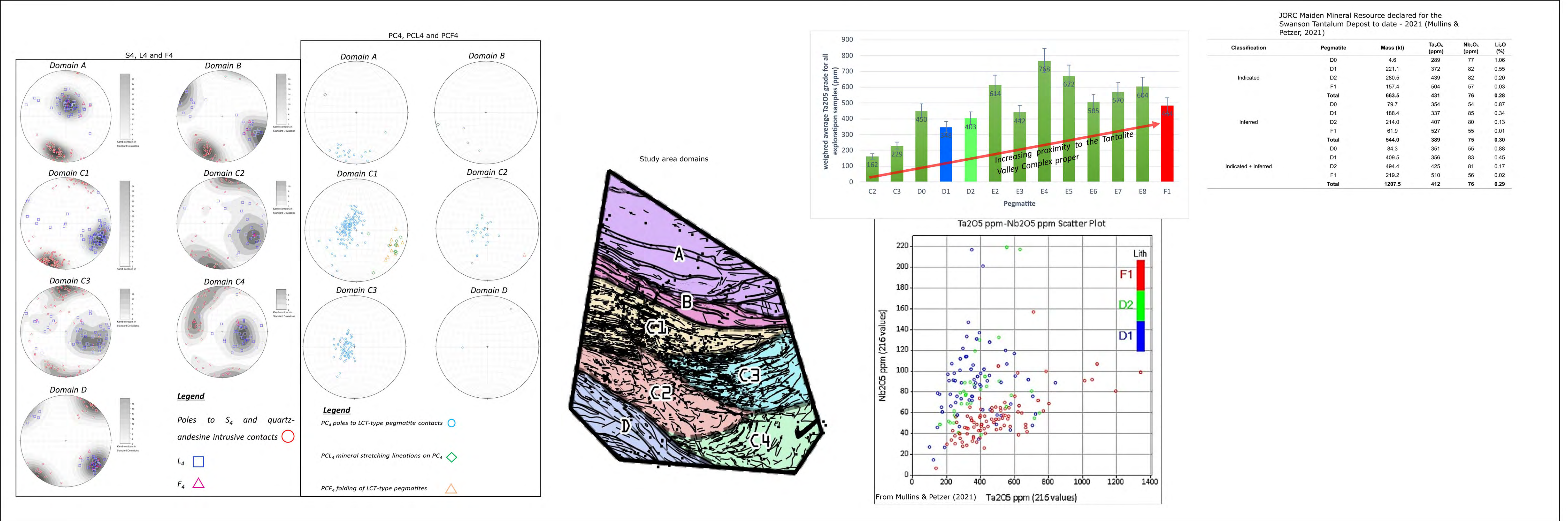
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APPENDIX I: DETAILED GEOLOGICAL MAP OF THE STUDY AREA



APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
1	138	50	F4 fold hinge	271585	6823561	D
2	290	33	F4 fold hinge	271700	6824177	C3
3	110	26	F4 fold hinge	271477	6823915	C2
4	108	24	F4 fold hinge	271484	6823922	C2
5	128	24	F4 fold hinge	271333	6823782	D
6	135	25	F4 fold hinge	271348	6823733	D
7	113	43	F4 fold hinge	271395	6823630	D
8	87	63	F4 fold hinge	271609	6824892	A
9	126	38	F4 fold hinge	271286	6824916	B
10	100	38	F4 fold hinge	271316	6824904	B
11	117	37	F4 fold hinge	271346	6824873	B
12	120	24	F4 fold hinge	271386	6824861	B
13	134	16	F4 fold hinge	270940	6824115	D
14	126	8	F4 fold hinge	270999	6824066	D
15	127	13	F4 fold hinge	270997	6824051	D
16	66	41	F4 fold hinge	272035	6824783	A
17	119	18	F4 fold hinge	271315	6823477	D
18	101	13	F4 fold hinge	271496	6824314	C1
19	54	50	F4 fold hinge	271540	6824830	A
20	7	70	F4 fold hinge	271828	6825089	A
21	24	45	F4 fold hinge	272133	6824712	A
22	9	63	F4 fold hinge	271127	6825294	A
23	65	57	F4 fold hinge	272187	6823547	C4
24	55	56	F4 fold hinge	272365	6824087	C3
25	355	55	F4 fold hinge	271120	6825164	A
26	74	80	Hydrothermal breccia	271264	6824572	C1
27	270	74	Hydrothermal breccia	271265	6824559	C1
28	60	67	Hydrothermal breccia	271281	6824537	C1
29	312	78	Hydrothermal breccia	272333	6823433	C4
30	230	70	Hydrothermal breccia	272333	6823433	C4
31	300	85	Hydrothermal breccia	271340	6823698	D
32	292	84	Hydrothermal breccia	271246	6823902	D
33	55	79	Hydrothermal breccia	271640	6823781	C2
34	120	85	Hydrothermal breccia	272017	6824378	C1
35	320	75	Hydrothermal breccia	272017	6824378	C1
36	70	84	Hydrothermal breccia	271438	6824120	C2
37	65	81	Hydrothermal breccia	271874	6823490	C4
38	305	67	Hydrothermal breccia	272722	6823718	C4
39	122	12	L4 mineral stretching lineation	271018	6824463	C1
40	104	45	L4 mineral stretching lineation	271023	6824421	C1
41	118	40	L4 mineral stretching lineation	271027	6824534	C1
42	106	24	L4 mineral stretching lineation	271028	6824375	C1
43	118	16	L4 mineral stretching lineation	271039	6824566	C1
44	110	11	L4 mineral stretching lineation	271055	6824608	C1
45	89	23	L4 mineral stretching lineation	271059	6824632	C1
46	110	16	L4 mineral stretching lineation	271069	6824772	C1
47	113	26	L4 mineral stretching lineation	271071	6824301	C2
48	300	60	L4 mineral stretching lineation	271080	6825281	A
49	58	48	L4 mineral stretching lineation	271091	6824207	C2

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
50	0	65	L4 mineral stretching lineation	271101	6825332	A
51	105	18	L4 mineral stretching lineation	271103	6824614	C1
52	351	50	L4 mineral stretching lineation	271107	6825194	A
53	106	28	L4 mineral stretching lineation	271108	6824186	C2
54	85	26	L4 mineral stretching lineation	271112	6824486	C1
55	99	5	L4 mineral stretching lineation	271114	6824545	C1
56	28	61	L4 mineral stretching lineation	271129	6825158	A
57	5	40	L4 mineral stretching lineation	271130	6825390	A
58	106	33	L4 mineral stretching lineation	271139	6824894	B
59	335	54	L4 mineral stretching lineation	271142	6825122	A
60	100	27	L4 mineral stretching lineation	271152	6824610	C1
61	98	34	L4 mineral stretching lineation	271162	6824105	C2
62	118	15	L4 mineral stretching lineation	271184	6824043	C2
63	122	26	L4 mineral stretching lineation	271187	6824805	C1
64	128	31	L4 mineral stretching lineation	271187	6824706	C1
65	115	33	L4 mineral stretching lineation	271189	6825028	B
66	132	23	L4 mineral stretching lineation	271208	6824728	C1
67	85	64	L4 mineral stretching lineation	271221	6824972	B
68	125	20	L4 mineral stretching lineation	271236	6824594	C1
69	132	46	L4 mineral stretching lineation	271243	6824707	C1
70	132	46	L4 mineral stretching lineation	271243	6824707	C1
71	132	46	L4 mineral stretching lineation	271243	6824707	C1
72	120	20	L4 mineral stretching lineation	271251	6824533	C1
73	135	23	L4 mineral stretching lineation	271256	6824760	C1
74	128	17	L4 mineral stretching lineation	271262	6824549	C1
75	93	13	L4 mineral stretching lineation	271263	6823964	C2
76	114	3	L4 mineral stretching lineation	271265	6824539	C1
77	142	35	L4 mineral stretching lineation	271271	6824629	C1
78	109	22	L4 mineral stretching lineation	271271	6824275	C1
79	98	26	L4 mineral stretching lineation	271277	6824309	C1
80	292	12	L4 mineral stretching lineation	271278	6824221	C2
81	128	39	L4 mineral stretching lineation	271286	6824916	B
82	130	24	L4 mineral stretching lineation	271297	6823882	D
83	94	24	L4 mineral stretching lineation	271297	6824376	C1
84	130	21	L4 mineral stretching lineation	271297	6824533	C1
85	132	23	L4 mineral stretching lineation	271302	6823842	D
86	124	7	L4 mineral stretching lineation	271330	6824137	C2
87	115	9	L4 mineral stretching lineation	271330	6824770	C1
88	110	18	L4 mineral stretching lineation	271340	6824415	C1
89	125	14	L4 mineral stretching lineation	271341	6823665	D
90	47	2	L4 mineral stretching lineation	271341	6824773	C1
91	118	38	L4 mineral stretching lineation	271346	6824873	B
92	135	13	L4 mineral stretching lineation	271347	6823764	D
93	302	4	L4 mineral stretching lineation	271351	6824786	C1
94	119	26	L4 mineral stretching lineation	271351	6823468	D
95	155	23	L4 mineral stretching lineation	271356	6824096	C2
96	287	3	L4 mineral stretching lineation	271358	6824796	B
97	287	3	L4 mineral stretching lineation	271358	6824796	B
98	287	3	L4 mineral stretching lineation	271358	6824796	B

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
99	118	34	L4 mineral stretching lineation	271363	6824433	C1
100	305	5	L4 mineral stretching lineation	271366	6824826	B
101	305	5	L4 mineral stretching lineation	271366	6824826	B
102	305	5	L4 mineral stretching lineation	271366	6824826	B
103	148	64	L4 mineral stretching lineation	271370	6824042	C2
104	304	5	L4 mineral stretching lineation	271371	6824817	B
105	304	5	L4 mineral stretching lineation	271371	6824817	B
106	304	5	L4 mineral stretching lineation	271371	6824817	B
107	95	16	L4 mineral stretching lineation	271382	6824447	C1
108	134	10	L4 mineral stretching lineation	271392	6824367	C1
109	121	12	L4 mineral stretching lineation	271393	6824512	C1
110	295	8	L4 mineral stretching lineation	271405	6823457	D
111	109	24	L4 mineral stretching lineation	271412	6824433	C1
112	112	32	L4 mineral stretching lineation	271418	6824445	C1
113	114	12	L4 mineral stretching lineation	271422	6824456	C1
114	114	12	L4 mineral stretching lineation	271422	6824456	C1
115	112	7	L4 mineral stretching lineation	271423	6824767	B
116	112	56	L4 mineral stretching lineation	271423	6824463	C1
117	125	35	L4 mineral stretching lineation	271425	6825366	A
118	90	23	L4 mineral stretching lineation	271426	6824351	C1
119	110	12	L4 mineral stretching lineation	271427	6824462	C1
120	121	16	L4 mineral stretching lineation	271439	6824355	C1
121	90	66	L4 mineral stretching lineation	271446	6824880	A
122	113	4	L4 mineral stretching lineation	271449	6824723	C1
123	306	8	L4 mineral stretching lineation	271459	6823436	D
124	120	34	L4 mineral stretching lineation	271461	6824657	C1
125	85	14	L4 mineral stretching lineation	271464	6824425	C1
126	10	63	L4 mineral stretching lineation	271465	6824865	A
127	135	20	L4 mineral stretching lineation	271480	6824473	C1
128	122	36	L4 mineral stretching lineation	271484	6824699	C1
129	49	69	L4 mineral stretching lineation	271485	6824872	A
130	115	25	L4 mineral stretching lineation	271488	6824697	C1
131	119	31	L4 mineral stretching lineation	271488	6823478	D
132	149	55	L4 mineral stretching lineation	271489	6823882	C2
133	123	18	L4 mineral stretching lineation	271494	6823591	D
134	118	36	L4 mineral stretching lineation	271495	6824637	C1
135	308	14	L4 mineral stretching lineation	271496	6823505	D
136	120	19	L4 mineral stretching lineation	271496	6824715	B
137	99	31	L4 mineral stretching lineation	271499	6824719	B
138	50	63	L4 mineral stretching lineation	271504	6824867	A
139	115	14	L4 mineral stretching lineation	271505	6824731	B
140	125	34	L4 mineral stretching lineation	271506	6824705	C1
141	109	15	L4 mineral stretching lineation	271509	6824739	B
142	110	16	L4 mineral stretching lineation	271516	6823855	C2
143	115	21	L4 mineral stretching lineation	271516	6824723	B
144	130	3	L4 mineral stretching lineation	271516	6824751	B
145	105	36	L4 mineral stretching lineation	271520	6824790	B
146	65	55	L4 mineral stretching lineation	271521	6824844	A
147	129	20	L4 mineral stretching lineation	271525	6823415	D

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
148	130	22	L4 mineral stretching lineation	271530	6824781	B
149	70	64	L4 mineral stretching lineation	271536	6824820	A
150	278	39	L4 mineral stretching lineation	271536	6824620	C1
151	318	15	L4 mineral stretching lineation	271558	6823348	D
152	138	5	L4 mineral stretching lineation	271558	6823462	D
153	32	45	L4 mineral stretching lineation	271561	6824826	A
154	300	22	L4 mineral stretching lineation	271565	6824856	A
155	111	25	L4 mineral stretching lineation	271571	6824561	C1
156	140	43	L4 mineral stretching lineation	271580	6823520	D
157	130	24	L4 mineral stretching lineation	271585	6823572	D
158	300	31	L4 mineral stretching lineation	271590	6824798	A
159	108	6	L4 mineral stretching lineation	271597	6824286	C1
160	96	8	L4 mineral stretching lineation	271599	6824400	C1
161	359	41	L4 mineral stretching lineation	271602	6824881	A
162	95	10	L4 mineral stretching lineation	271608	6824249	C3
163	300	3	L4 mineral stretching lineation	271623	6824374	C1
164	310	61	L4 mineral stretching lineation	271639	6824185	C3
165	128	14	L4 mineral stretching lineation	271641	6824345	C1
166	150	38	L4 mineral stretching lineation	271642	6823362	D
167	112	8	L4 mineral stretching lineation	271652	6824567	C1
168	128	38	L4 mineral stretching lineation	271653	6823578	D
169	36	65	L4 mineral stretching lineation	271654	6824896	A
170	55	26	L4 mineral stretching lineation	271658	6823958	C2
171	108	13	L4 mineral stretching lineation	271669	6824147	C3
172	80	7	L4 mineral stretching lineation	271671	6823919	C2
173	118	45	L4 mineral stretching lineation	271671	6823598	C4
174	41	75	L4 mineral stretching lineation	271683	6825310	A
175	128	29	L4 mineral stretching lineation	271694	6823661	C2
176	122	24	L4 mineral stretching lineation	271698	6823386	D
177	290	33	L4 mineral stretching lineation	271700	6824175	C3
178	355	68	L4 mineral stretching lineation	271716	6824932	A
179	125	25	L4 mineral stretching lineation	271739	6823424	D
180	100	10	L4 mineral stretching lineation	271750	6824152	C3
181	150	27	L4 mineral stretching lineation	271756	6823885	C2
182	25	67	L4 mineral stretching lineation	271764	6824933	A
183	104	18	L4 mineral stretching lineation	271774	6824457	C1
184	294	5	L4 mineral stretching lineation	271776	6824069	C3
185	280	15	L4 mineral stretching lineation	271777	6824339	C1
186	5	62	L4 mineral stretching lineation	271778	6825277	A
187	91	5	L4 mineral stretching lineation	271786	6824420	C1
188	310	22	L4 mineral stretching lineation	271790	6823469	D
189	114	42	L4 mineral stretching lineation	271798	6823974	C2
190	287	29	L4 mineral stretching lineation	271814	6824135	C3
191	3	63	L4 mineral stretching lineation	271820	6825065	A
192	114	11	L4 mineral stretching lineation	271821	6824013	C3
193	7	54	L4 mineral stretching lineation	271827	6825003	A
194	116	57	L4 mineral stretching lineation	271832	6823828	C2
195	115	19	L4 mineral stretching lineation	271833	6824270	C3
196	77	71	L4 mineral stretching lineation	271836	6824249	C3

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
197	118	36	L4 mineral stretching lineation	271849	6824052	C3
198	8	80	L4 mineral stretching lineation	271858	6825121	A
199	128	54	L4 mineral stretching lineation	271860	6824293	C1
200	160	68	L4 mineral stretching lineation	271864	6824144	C3
201	114	12	L4 mineral stretching lineation	271870	6824302	C1
202	72	5	L4 mineral stretching lineation	271879	6824343	C1
203	323	64	L4 mineral stretching lineation	271890	6825232	A
204	118	28	L4 mineral stretching lineation	271895	6824436	C1
205	115	18	L4 mineral stretching lineation	271910	6823511	C4
206	31	96	L4 mineral stretching lineation	271915	6824399	C1
207	90	15	L4 mineral stretching lineation	271915	6824315	C1
208	109	31	L4 mineral stretching lineation	271946	6824293	C1
209	95	48	L4 mineral stretching lineation	271949	6823515	C4
210	298	24	L4 mineral stretching lineation	271950	6824517	B
211	100	39	L4 mineral stretching lineation	271961	6824270	C3
212	120	45	L4 mineral stretching lineation	271991	6824150	C3
213	275	15	L4 mineral stretching lineation	271994	6824560	B
214	80	46	L4 mineral stretching lineation	271995	6823573	C4
215	130	44	L4 mineral stretching lineation	271998	6824125	C3
216	288	35	L4 mineral stretching lineation	271999	6824186	C3
217	115	10	L4 mineral stretching lineation	272012	6823638	C2
218	80	10	L4 mineral stretching lineation	272014	6824245	C3
219	105	25	L4 mineral stretching lineation	272014	6824043	C3
220	105	60	L4 mineral stretching lineation	272015	6824221	C3
221	112	15	L4 mineral stretching lineation	272017	6824592	B
222	85	5	L4 mineral stretching lineation	272030	6823993	C3
223	295	31	L4 mineral stretching lineation	272057	6824622	B
224	45	36	L4 mineral stretching lineation	272072	6823832	C2
225	92	35	L4 mineral stretching lineation	272073	6823928	C3
226	128	25	L4 mineral stretching lineation	272082	6823911	C3
227	102	40	L4 mineral stretching lineation	272102	6824307	C3
228	81	43	L4 mineral stretching lineation	272117	6823799	C2
229	269	52	L4 mineral stretching lineation	272124	6824222	C3
230	315	48	L4 mineral stretching lineation	272124	6824651	B
231	110	56	L4 mineral stretching lineation	272127	6823791	C2
232	75	53	L4 mineral stretching lineation	272131	6823581	C4
233	118	30	L4 mineral stretching lineation	272137	6823707	C2
234	305	40	L4 mineral stretching lineation	272142	6823583	C4
235	100	36	L4 mineral stretching lineation	272146	6823654	C4
236	133	40	L4 mineral stretching lineation	272147	6823683	C4
237	87	17	L4 mineral stretching lineation	272151	6824028	C3
238	120	15	L4 mineral stretching lineation	272152	6823977	C3
239	17	73	L4 mineral stretching lineation	272153	6824715	A
240	112	24	L4 mineral stretching lineation	272164	6823896	C3
241	120	43	L4 mineral stretching lineation	272171	6823920	C3
242	70	58	L4 mineral stretching lineation	272171	6823557	C4
243	12	63	L4 mineral stretching lineation	272178	6823795	C2
244	130	45	L4 mineral stretching lineation	272189	6824146	C3
245	315	52	L4 mineral stretching lineation	272193	6824174	C3

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fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
246	297	78	L4 mineral stretching lineation	272194	6824769	A
247	75	55	L4 mineral stretching lineation	272209	6823531	C4
248	136	54	L4 mineral stretching lineation	272227	6823748	C4
249	270	36	L4 mineral stretching lineation	272249	6824422	C1
250	120	34	L4 mineral stretching lineation	272250	6823695	C4
251	88	67	L4 mineral stretching lineation	272255	6823801	C4
252	350	49	L4 mineral stretching lineation	272288	6823818	C2
253	19	75	L4 mineral stretching lineation	272289	6824856	A
254	10	73	L4 mineral stretching lineation	272302	6824460	C1
255	140	46	L4 mineral stretching lineation	272304	6824263	C3
256	81	13	L4 mineral stretching lineation	272307	6823462	C4
257	96	26	L4 mineral stretching lineation	272307	6823830	C3
258	240	25	L4 mineral stretching lineation	272310	6824188	C3
259	82	63	L4 mineral stretching lineation	272316	6823864	C3
260	65	56	L4 mineral stretching lineation	272317	6824056	C3
261	107	28	L4 mineral stretching lineation	272323	6823454	C4
262	95	55	L4 mineral stretching lineation	272332	6823977	C3
263	270	30	L4 mineral stretching lineation	272343	6824517	B
264	105	7	L4 mineral stretching lineation	272354	6823429	C4
265	141	56	L4 mineral stretching lineation	272363	6823627	C4
266	340	60	L4 mineral stretching lineation	272373	6824613	A
267	286	10	L4 mineral stretching lineation	272377	6824892	A
268	128	51	L4 mineral stretching lineation	272381	6823748	C4
269	88	64	L4 mineral stretching lineation	272386	6823502	C4
270	42	57	L4 mineral stretching lineation	272410	6824110	C3
271	5	73	L4 mineral stretching lineation	272420	6824654	A
272	172	87	L4 mineral stretching lineation	272436	6823895	C3
273	90	85	L4 mineral stretching lineation	272450	6824797	A
274	0	76	L4 mineral stretching lineation	272455	6824717	A
275	154	48	L4 mineral stretching lineation	272456	6823543	C4
276	96	59	L4 mineral stretching lineation	272461	6823837	C4
277	82	23	L4 mineral stretching lineation	272466	6823868	C3
278	63	45	L4 mineral stretching lineation	272474	6823828	C4
279	130	58	L4 mineral stretching lineation	272540	6824005	C3
280	167	72	L4 mineral stretching lineation	272567	6823796	C4
281	51	31	L4 mineral stretching lineation	272602	6823991	C3
282	355	76	L4 mineral stretching lineation	272606	6823741	C4
283	107	41	L4 mineral stretching lineation	272616	6823642	C4
284	133	63	L4 mineral stretching lineation	272619	6823966	C3
285	65	46	L4 mineral stretching lineation	272646	6823458	C4
286	282	57	L4 mineral stretching lineation	272665	6823913	C3
287	70	26	L4 mineral stretching lineation	272684	6823502	C4
288	79	55	L4 mineral stretching lineation	272684	6823889	C4
289	105	51	L4 mineral stretching lineation	272702	6823635	C4
290	110	44	L4 mineral stretching lineation	272710	6823860	C4
291	260	72	L4 mineral stretching lineation	272736	6823827	C4
292	22	13	L4 mineral stretching lineation	272756	6823791	C4
293	100	55	L4 mineral stretching lineation	272797	6823748	C4
294	163	75	L4 mineral stretching lineation	272815	6823717	C4

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fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
295	134	16	L4 mineral stretching lineation	270940	6824115	D
296	129	14	L4 mineral stretching lineation	270997	6824051	D
297	125	10	L4 mineral stretching lineation	271034	6824002	D
298	108	24	L4 mineral stretching lineation	271047	6823959	D
299	115	6	L4 mineral stretching lineation	271037	6823898	D
300	136	10	L4 mineral stretching lineation	271114	6823906	D
301	139	24	L4 mineral stretching lineation	271248	6823897	D
302	228	30	L4 mineral stretching lineation	272518	6824230	C3
303	149	63	L4 mineral stretching lineation	272472	6824292	C3
304	55	34	L4 mineral stretching lineation	272469	6824312	C3
305	296	60	L4 mineral stretching lineation	272502	6824349	C3
306	89	69	L4 mineral stretching lineation	272482	6824415	C3
307	105	53	L4 mineral stretching lineation	272492	6824465	C3
308	256	61	L4 mineral stretching lineation	272467	6824516	C1
309	286	31	L4 mineral stretching lineation	272413	6824560	B
310	105	50	L4 mineral stretching lineation	272239	6824600	B
311	31	60	L4 mineral stretching lineation	272043	6824729	A
312	65	40	L4 mineral stretching lineation	272035	6824783	A
313	74	79	L4 mineral stretching lineation	272061	6824821	A
314	70	54	L4 mineral stretching lineation	272066	6824863	A
315	22	69	L4 mineral stretching lineation	272009	6824918	A
316	121	16	L4 mineral stretching lineation	271298	6823485	D
317	35	85	Normal fault	271218	6824677	C1
318	163	67	Normal fault	272247	6823904	C3
319	153	64	Normal fault	272239	6823930	C3
320	65	73	Normal fault	271998	6823916	C3
321	11	61	Normal fault	271981	6823807	C2
322	15	68	Normal fault	272041	6824101	C3
323	34	64	Normal fault	272076	6824084	C3
324	9	63	Normal fault	271983	6824075	C3
325	360	61	Normal fault	271989	6824062	C3
326	357	57	Normal fault	271956	6824062	C3
327	350	86	Normal fault	271972	6824039	C3
328	34	45	Normal fault	271962	6824001	C3
329	24	72	Normal fault	271920	6823956	C3
330	20	74	Normal fault	271941	6823963	C3
331	61	77	Normal fault	271964	6823965	C3
332	67	70	Normal fault	271977	6823964	C3
333	120	90	Normal fault	272118	6824012	C3
334	4	29	Normal fault	272116	6824010	C3
335	146	45	Normal fault	272116	6823998	C3
336	160	70	Normal fault	272022	6823918	C3
337	22	80	Normal fault	271985	6823924	C3
338	181	65	Normal fault	272045	6824118	C3
339	36	60	Normal fault	272113	6824066	C3
340	275	83	Normal fault	272213	6823883	C3
341	7	66	Normal fault	271908	6823958	C2
342	45	84	Normal fault	271898	6823963	C2
343	31	81	Normal fault	271902	6823961	C2

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fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
344	31	89	Normal fault	271925	6823949	C2
345	35	77	Normal fault	271933	6823943	C2
346	23	89	Normal fault	271942	6823938	C2
347	200	88	Normal fault	271949	6823934	C2
348	205	63	Normal fault	271958	6823930	C2
349	196	73	Normal fault	271966	6823927	C2
350	28	88	Normal fault	271987	6823918	C3
351	38	67	Normal fault	271995	6823913	C3
352	15	68	Normal fault	272069	6823876	C2
353	25	61	Normal fault	272061	6823879	C2
354	15	79	Normal fault	272080	6823871	C2
355	30	84	Normal fault	272089	6823867	C2
356	28	84	Normal fault	272099	6823866	C2
357	29	84	Normal fault	272117	6823863	C3
358	343	62	Normal fault	272135	6823861	C3
359	19	66	Normal fault	272003	6824097	C3
360	12	76	Normal fault	272002	6824104	C3
361	29	79	Normal fault	272013	6824101	C3
362	27	79	Normal fault	272027	6824097	C3
363	12	88	Normal fault	272032	6824096	C3
364	198	84	Normal fault	272071	6824079	C3
365	200	79	Normal fault	272093	6824076	C3
366	15	87	Normal fault	272029	6824089	C3
367	218	86	Normal fault	271543	6824619	C1
368	22	82	Normal fault	271523	6824628	C1
369	28	85	Normal fault	271512	6824633	C1
370	33	85	Normal fault	271497	6824641	C1
371	29	68	Normal fault	271485	6824645	C1
372	30	88	Normal fault	271470	6824650	C1
373	25	82	Normal fault	271456	6824659	C1
374	28	88	Normal fault	271433	6824669	C1
375	16	88	Normal fault	271414	6824676	C1
376	25	85	Normal fault	271390	6824684	C1
377	25	69	Normal fault	271380	6824655	C1
378	25	80	Normal fault	271419	6824632	C1
379	210	88	Normal fault	271451	6824608	C1
380	22	85	Normal fault	271482	6824607	C1
381	215	75	Normal fault	271497	6824602	C1
382	23	86	Normal fault	271515	6824596	C1
383	24	72	Normal fault	271593	6824556	C1
384	158	70	Normal fault	272024	6823924	C3
385	197	80	Normal fault	272005	6823923	C3
386	168	45	Normal fault	272119	6823994	C3
387	195	65	Normal fault	272032	6824121	C3
388	14	70	Normal fault	272038	6824101	C3
389	196	60	Normal fault	271755	6824128	C3
390	28	85	Normal fault	271596	6824614	C1
391	8	80	Normal fault	271175	6824517	C1
392	10	80	Normal fault	271124	6824518	C1

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fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
393	197	80	Normal fault	271049	6824515	C1
394	29	89	Normal fault	271051	6824583	C1
395	28	85	Normal fault	271051	6824618	C1
396	15	80	Normal fault	271008	6824635	C1
397	8	77	Normal fault	271136	6824610	C1
398	81	10	Pegmatite contact	271018	6824706	C1
399	180	29	Pegmatite contact	271054	6824665	C1
400	178	31	Pegmatite contact	271058	6824624	C1
401	359	21	Pegmatite contact	271076	6824224	C2
402	185	30	Pegmatite contact	271079	6824795	C1
403	15	74	Pegmatite contact	271093	6825226	A
404	176	14	Pegmatite contact	271102	6824595	C1
405	12	85	Pegmatite contact	271104	6825347	A
406	180	38	Pegmatite contact	271110	6824481	C1
407	180	38	Pegmatite contact	271110	6824481	C1
408	355	24	Pegmatite contact	271122	6824496	C1
409	71	11	Pegmatite contact	271123	6824842	C1
410	10	64	Pegmatite contact	271127	6825157	A
411	21	46	Pegmatite contact	271129	6824159	C2
412	50	15	Pegmatite contact	271132	6824470	C1
413	50	15	Pegmatite contact	271132	6824470	C1
414	140	13	Pegmatite contact	271134	6824474	C1
415	26	76	Pegmatite contact	271151	6825424	A
416	82	21	Pegmatite contact	271151	6824501	C1
417	82	21	Pegmatite contact	271151	6824501	C1
418	26	59	Pegmatite contact	271171	6825063	A
419	190	22	Pegmatite contact	271173	6824615	C1
420	220	20	Pegmatite contact	271184	6824485	C1
421	175	26	Pegmatite contact	271191	6824643	C1
422	55	44	Pegmatite contact	271215	6825003	B
423	294	10	Pegmatite contact	271228	6824690	C1
424	189	28	Pegmatite contact	271231	6824656	C1
425	353	9	Pegmatite contact	271238	6823985	C2
426	232	14	Pegmatite contact	271255	6824705	C1
427	100	14	Pegmatite contact	271260	6824725	C1
428	200	28	Pegmatite contact	271273	6824679	C1
429	87	22	Pegmatite contact	271275	6824644	C1
430	65	18	Pegmatite contact	271294	6824587	C1
431	155	10	Pegmatite contact	271299	6824638	C1
432	82	22	Pegmatite contact	271300	6824754	C1
433	89	15	Pegmatite contact	271310	6824607	C1
434	35	79	Pegmatite contact	271313	6825447	A
435	40	55	Pegmatite contact	271315	6824491	C1
436	65	32	Pegmatite contact	271317	6824490	C1
437	74	64	Pegmatite contact	271317	6824510	C1
438	122	19	Pegmatite contact	271318	6824615	C1
439	82	18	Pegmatite contact	271318	6824615	C1
440	97	16	Pegmatite contact	271332	6824471	C1
441	85	31	Pegmatite contact	271333	6824465	C1

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
442	141	26	Pegmatite contact	271335	6824673	C1
443	108	16	Pegmatite contact	271339	6824577	C1
444	50	34	Pegmatite contact	271342	6824432	C1
445	60	56	Pegmatite contact	271343	6824421	C1
446	27	89	Pegmatite contact	271345	6824416	C1
447	168	21	Pegmatite contact	271345	6824671	C1
448	35	72	Pegmatite contact	271346	6824410	C1
449	174	39	Pegmatite contact	271363	6824671	C1
450	120	13	Pegmatite contact	271366	6824562	C1
451	126	12	Pegmatite contact	271372	6824541	C1
452	31	58	Pegmatite contact	271377	6824876	B
453	89	40	Pegmatite contact	271379	6823465	D
454	195	19	Pegmatite contact	271380	6824678	C1
455	36	29	Pegmatite contact	271384	6824648	C1
456	153	24	Pegmatite contact	271385	6824609	C1
457	90	15	Pegmatite contact	271390	6824538	C1
458	115	19	Pegmatite contact	271390	6824465	C1
459	151	18	Pegmatite contact	271392	6824569	C1
460	68	18	Pegmatite contact	271397	6824542	C1
461	46	55	Pegmatite contact	271400	6824358	C1
462	172	24	Pegmatite contact	271402	6824688	C1
463	98	32	Pegmatite contact	271409	6824344	C1
464	128	23	Pegmatite contact	271410	6824478	C1
465	170	9	Pegmatite contact	271410	6824373	C1
466	87	20	Pegmatite contact	271411	6824510	C1
467	70	45	Pegmatite contact	271411	6824352	C1
468	52	24	Pegmatite contact	271413	6824525	C1
469	181	22	Pegmatite contact	271418	6824600	C1
470	45	30	Pegmatite contact	271420	6824419	C1
471	132	22	Pegmatite contact	271421	6824481	C1
472	164	18	Pegmatite contact	271422	6824607	C1
473	89	19	Pegmatite contact	271422	6824587	C1
474	83	23	Pegmatite contact	271425	6824520	C1
475	129	20	Pegmatite contact	271425	6824357	C1
476	116	24	Pegmatite contact	271427	6824379	C1
477	175	33	Pegmatite contact	271428	6824700	C1
478	99	20	Pegmatite contact	271430	6824514	C1
479	96	26	Pegmatite contact	271431	6824350	C1
480	134	12	Pegmatite contact	271432	6824493	C1
481	78	21	Pegmatite contact	271445	6824420	C1
482	143	20	Pegmatite contact	271448	6824686	C1
483	58	28	Pegmatite contact	271452	6824438	C1
484	72	17	Pegmatite contact	271452	6824526	C1
485	154	20	Pegmatite contact	271453	6824546	C1
486	75	18	Pegmatite contact	271455	6824387	C1
487	28	31	Pegmatite contact	271456	6824458	C1
488	24	45	Pegmatite contact	271457	6824529	C1
489	122	14	Pegmatite contact	271458	6824539	C1
490	106	23	Pegmatite contact	271468	6824471	C1

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fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
491	66	12	Pegmatite contact	271468	6824555	C1
492	115	25	Pegmatite contact	271483	6824502	C1
493	169	35	Pegmatite contact	271484	6824583	C1
494	113	21	Pegmatite contact	271485	6824468	C1
495	27	66	Pegmatite contact	271491	6824873	A
496	27	66	Pegmatite contact	271491	6824873	A
497	324	24	Pegmatite contact	271492	6824524	C1
498	194	29	Pegmatite contact	271497	6824595	C1
499	168	22	Pegmatite contact	271502	6824503	C1
500	118	20	Pegmatite contact	271502	6824590	C1
501	75	26	Pegmatite contact	271516	6824519	C1
502	10	64	Pegmatite contact	271518	6824773	B
503	171	16	Pegmatite contact	271530	6824610	C1
504	146	5	Pegmatite contact	271534	6824610	C1
505	164	20	Pegmatite contact	271535	6824600	C1
506	194	16	Pegmatite contact	271539	6824283	C1
507	20	79	Pegmatite contact	271540	6824830	A
508	134	22	Pegmatite contact	271544	6824549	C1
509	82	27	Pegmatite contact	271551	6824304	C1
510	119	11	Pegmatite contact	271560	6824560	C1
511	304	58	Pegmatite contact	271564	6824850	A
512	190	12	Pegmatite contact	271565	6824586	C1
513	128	23	Pegmatite contact	271565	6824283	C1
514	64	37	Pegmatite contact	271571	6824250	C3
515	130	19	Pegmatite contact	271574	6824587	C1
516	95	33	Pegmatite contact	271575	6824229	C3
517	164	14	Pegmatite contact	271581	6824584	C1
518	118	11	Pegmatite contact	271582	6824444	C1
519	50	31	Pegmatite contact	271584	6824328	C1
520	126	14	Pegmatite contact	271584	6824462	C1
521	107	19	Pegmatite contact	271586	6824302	C1
522	58	26	Pegmatite contact	271589	6824361	C1
523	11	68	Pegmatite contact	271593	6824875	A
524	25	76	Pegmatite contact	271597	6824430	C1
525	171	16	Pegmatite contact	271597	6824311	C1
526	49	15	Pegmatite contact	271598	6824335	C1
527	64	21	Pegmatite contact	271608	6824268	C1
528	145	17	Pegmatite contact	271608	6824492	C1
529	175	28	Pegmatite contact	271609	6824459	C1
530	128	11	Pegmatite contact	271610	6824390	C1
531	114	12	Pegmatite contact	271612	6824284	C1
532	50	29	Pegmatite contact	271613	6824214	C3
533	30	56	Pegmatite contact	271615	6824207	C3
534	205	16	Pegmatite contact	271625	6824360	C1
535	106	18	Pegmatite contact	271626	6824339	C1
536	145	14	Pegmatite contact	271629	6824339	C1
537	153	24	Pegmatite contact	271636	6824222	C3
538	151	24	Pegmatite contact	271638	6824264	C3
539	92	12	Pegmatite contact	271641	6824269	C1

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
540	91	11	Pegmatite contact	271643	6824267	C1
541	49	18	Pegmatite contact	271643	6824202	C3
542	161	17	Pegmatite contact	271644	6824279	C1
543	123	19	Pegmatite contact	271648	6824343	C1
544	18	68	Pegmatite contact	271648	6825352	A
545	63	12	Pegmatite contact	271657	6824117	C2
546	24	62	Pegmatite contact	271659	6823989	C2
547	79	5	Pegmatite contact	271660	6824097	C2
548	81	32	Pegmatite contact	271661	6823983	C2
549	21	47	Pegmatite contact	271663	6824027	C2
550	51	31	Pegmatite contact	271664	6824025	C2
551	91	6	Pegmatite contact	271669	6824037	C2
552	111	24	Pegmatite contact	271674	6824250	C3
553	20	12	Pegmatite contact	271675	6824173	C3
554	182	9	Pegmatite contact	271681	6824078	C2
555	111	18	Pegmatite contact	271684	6824125	C2
556	91	21	Pegmatite contact	271685	6824133	C3
557	111	35	Pegmatite contact	271685	6824133	C3
558	35	9	Pegmatite contact	271688	6824156	C3
559	55	26	Pegmatite contact	271695	6824236	C3
560	300	21	Pegmatite contact	271696	6823988	C2
561	130	15	Pegmatite contact	271703	6824437	C1
562	65	24	Pegmatite contact	271704	6824019	C2
563	108	14	Pegmatite contact	271705	6824120	C3
564	125	25	Pegmatite contact	271709	6824125	C3
565	111	4	Pegmatite contact	271715	6824086	C2
566	115	12	Pegmatite contact	271716	6824111	C3
567	101	16	Pegmatite contact	271716	6824325	C1
568	94	16	Pegmatite contact	271716	6824072	C2
569	82	24	Pegmatite contact	271717	6824071	C2
570	73	19	Pegmatite contact	271718	6824025	C2
571	160	24	Pegmatite contact	271718	6824026	C2
572	155	19	Pegmatite contact	271724	6824059	C2
573	159	16	Pegmatite contact	271741	6824115	C3
574	155	25	Pegmatite contact	271749	6824124	C3
575	128	20	Pegmatite contact	271753	6824124	C3
576	58	14	Pegmatite contact	271755	6824222	C3
577	160	28	Pegmatite contact	271759	6824122	C3
578	115	12	Pegmatite contact	271763	6824127	C3
579	85	30	Pegmatite contact	271763	6824125	C3
580	118	19	Pegmatite contact	271764	6824343	C1
581	130	11	Pegmatite contact	271766	6824205	C3
582	98	26	Pegmatite contact	271767	6824138	C3
583	3	71	Pegmatite contact	271768	6824939	A
584	100	27	Pegmatite contact	271768	6824131	C3
585	46	15	Pegmatite contact	271772	6824230	C3
586	124	12	Pegmatite contact	271775	6824143	C3
587	136	5	Pegmatite contact	271776	6824146	C3
588	27	19	Pegmatite contact	271776	6824212	C3

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
589	166	20	Pegmatite contact	271792	6824149	C3
590	125	15	Pegmatite contact	271794	6824151	C3
591	135	9	Pegmatite contact	271795	6824155	C3
592	100	8	Pegmatite contact	271797	6824334	C1
593	29	15	Pegmatite contact	271800	6824284	C1
594	133	15	Pegmatite contact	271814	6824381	C1
595	120	14	Pegmatite contact	271815	6824295	C1
596	26	22	Pegmatite contact	271854	6824317	C1
597	110	21	Pegmatite contact	271856	6824321	C1
598	136	14	Pegmatite contact	271860	6824406	C1
599	186	11	Pegmatite contact	271868	6824290	C1
600	43	20	Pegmatite contact	271882	6824323	C1
601	23	16	Pegmatite contact	271887	6824374	C1
602	153	28	Pegmatite contact	271894	6824382	C1
603	147	14	Pegmatite contact	271896	6824418	C1
604	47	14	Pegmatite contact	271901	6824333	C1
605	114	17	Pegmatite contact	271921	6823994	C3
606	47	20	Pegmatite contact	271932	6823950	C3
607	61	13	Pegmatite contact	271936	6824346	C1
608	140	4	Pegmatite contact	271941	6824417	C1
609	43	14	Pegmatite contact	271961	6823953	C3
610	35	16	Pegmatite contact	271965	6823966	C3
611	43	30	Pegmatite contact	271965	6824409	C1
612	39	20	Pegmatite contact	271970	6824071	C3
613	80	17	Pegmatite contact	271982	6824009	C3
614	118	12	Pegmatite contact	271992	6824380	C1
615	134	19	Pegmatite contact	272004	6824096	C3
616	61	17	Pegmatite contact	272009	6823956	C3
617	88	14	Pegmatite contact	272011	6824109	C3
618	83	9	Pegmatite contact	272016	6824088	C3
619	67	20	Pegmatite contact	272024	6823978	C3
620	120	15	Pegmatite contact	272032	6824108	C3
621	98	5	Pegmatite contact	272051	6824074	C3
622	29	49	Pegmatite contact	272054	6824120	C3
623	76	21	Pegmatite contact	272058	6824098	C3
624	78	19	Pegmatite contact	272070	6824097	C3
625	40	16	Pegmatite contact	272071	6824072	C3
626	166	16	Pegmatite contact	272073	6823988	C3
627	69	18	Pegmatite contact	272076	6824064	C3
628	49	13	Pegmatite contact	272084	6824105	C3
629	1	17	Pegmatite contact	272084	6824059	C3
630	358	22	Pegmatite contact	272098	6823875	C3
631	116	26	Pegmatite contact	272103	6823993	C3
632	114	12	Pegmatite contact	272103	6823993	C3
633	134	8	Pegmatite contact	272103	6823993	C3
634	100	17	Pegmatite contact	272106	6824038	C3
635	93	16	Pegmatite contact	272113	6824112	C3
636	62	22	Pegmatite contact	272115	6824014	C3
637	22	17	Pegmatite contact	272116	6823880	C3

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
638	69	16	Pegmatite contact	272117	6824112	C3
639	64	20	Pegmatite contact	272120	6824040	C3
640	49	21	Pegmatite contact	272125	6824005	C3
641	160	3	Pegmatite contact	272131	6823982	C3
642	31	8	Pegmatite contact	272140	6823897	C3
643	46	21	Pegmatite contact	272152	6823912	C3
644	52	16	Pegmatite contact	272153	6824061	C3
645	29	14	Pegmatite contact	272186	6823839	C2
646	62	11	Pegmatite contact	272189	6823968	C3
647	39	10	Pegmatite contact	272257	6823888	C3
648	31	18	Pegmatite contact	272288	6823824	C3
649	347	68	Pegmatite contact	272371	6824888	A
650	340	68	Pegmatite contact	272412	6824823	A
651	22	82	Pegmatite contact	272448	6824783	A
652	11	9	Pegmatite contact	271139	6824053	C2
653	5	25	Pegmatite contact	271069	6824111	C2
654	205	12	Pegmatite contact	271013	6824149	C2
655	212	76	Pegmatite contact	271034	6824002	D
656	30	61	Pegmatite contact	272045	6824732	A
657	353	75	Pegmatite contact	272057	6824827	A
658	347	86	Pegmatite contact	272075	6824858	A
659	9	76	Pegmatite contact	272009	6824914	A
660	122	20	Pegmatite contact	271930	6824389	C1
661	167	40	Pegmatite contact	271998	6824489	C1
662	35	28	Pegmatite contact	271787	6824231	C3
663	93	21	Pegmatite contact	271693	6824359	C1
664	106	16	Pegmatite contact	271749	6824352	C1
665	123	23	Pegmatite contact	271796	6824356	C1
666	114	17	Pegmatite contact	271818	6824345	C1
667	157	10	Pegmatite contact	271786	6824426	C1
668	164	14	Pegmatite contact	271668	6824447	C1
669	32	25	Pegmatite contact	271740	6824207	C3
670	142	25	Pegmatite contact	271978	6824466	C1
681	285	110	Pegmatite contact mineral stretching lineation	271122	6824496	C1
682	118	14	Pegmatite contact mineral stretching lineation	271151	6824501	C1
683	99	14	Pegmatite contact mineral stretching lineation	271260	6824725	C1
684	158	12	Pegmatite contact mineral stretching lineation	271271	6824661	C1
685	119	15	Pegmatite contact mineral stretching lineation	271390	6824538	C1
686	120	12	Pegmatite contact mineral stretching lineation	271395	6824536	C1
687	115	30	Pegmatite contact mineral stretching lineation	271409	6824344	C1
688	110	19	Pegmatite contact mineral stretching lineation	271425	6824357	C1
689	111	19	Pegmatite contact mineral stretching lineation	271481	6824514	C1
690	105	20	Pegmatite contact mineral stretching lineation	271481	6824554	C1
691	256	4	Pegmatite contact mineral stretching lineation	271521	6824773	B
692	300	31	Pegmatite contact mineral stretching lineation	271590	6824798	A
671	105	8	Pegmatite F4 fold hinge	271228	6824690	C1
672	135	20	Pegmatite F4 fold hinge	271236	6824669	C1

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fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
673	120	22	Pegmatite F4 fold hinge	271260	6824693	C1
674	105	30	Pegmatite F4 fold hinge	271262	6824702	C1
675	110	16	Pegmatite F4 fold hinge	271310	6824755	C1
676	122	12	Pegmatite F4 fold hinge	271389	6824544	C1
677	88	24	Pegmatite F4 fold hinge	271418	6824419	C1
678	112	29	Pegmatite F4 fold hinge	271423	6824347	C1
679	130	21	Pegmatite F4 fold hinge	271431	6824350	C1
680	125	13	Pegmatite F4 fold hinge	271715	6824070	C2
693	28	68	Quartz vein contact	271135	6824532	C1
694	18	64	Quartz vein contact	271125	6824503	C1
695	22	86	Quartz vein contact	271116	6824509	C1
696	18	65	Quartz vein contact	271135	6824506	C1
697	16	86	Quartz vein contact	271152	6824501	C1
698	35	53	Quartz vein contact	271532	6823837	C2
699	128	25	Quartz vein contact	271297	6824376	C1
700	149	33	Quartz vein contact	271030	6824514	C1
701	20	30	Quartz vein contact	271033	6824138	C2
702	111	6	Quartz vein contact mineral stretching lineation	271116	6824509	C1
703	113	15	Quartz vein contact mineral stretching lineation	271135	6824532	C1
704	300	28	Quartz vein contact mineral stretching lineation	271152	6824501	C1
705	79	25	Quartz vein contact mineral stretching lineation	271146	6824509	C1
706	118	10	Quartz vein contact mineral stretching lineation	271532	6823837	C2
707	115	10	Quartz vein contact mineral stretching lineation	271033	6824138	C2
708	200	89	S4 mylonitic foliation	271018	6824463	C1
709	190	89	S4 mylonitic foliation	271023	6824421	C1
710	202	84	S4 mylonitic foliation	271027	6824534	C1
711	10	84	S4 mylonitic foliation	271028	6824375	C1
712	31	80	S4 mylonitic foliation	271039	6824566	C1
713	16	76	S4 mylonitic foliation	271055	6824608	C1
714	19	74	S4 mylonitic foliation	271059	6824632	C1
715	186	58	S4 mylonitic foliation	271071	6824301	C2
716	11	75	S4 mylonitic foliation	271074	6824783	C1
717	16	89	S4 mylonitic foliation	271080	6825281	A
718	13	85	S4 mylonitic foliation	271084	6824613	C1
719	23	64	S4 mylonitic foliation	271091	6824207	C2
720	15	82	S4 mylonitic foliation	271098	6824575	C1
721	14	69	S4 mylonitic foliation	271101	6825332	A
722	11	88	S4 mylonitic foliation	271103	6824614	C1
723	19	66	S4 mylonitic foliation	271107	6825194	A
724	190	82	S4 mylonitic foliation	271108	6824186	C2
725	185	87	S4 mylonitic foliation	271112	6824486	C1
726	10	83	S4 mylonitic foliation	271114	6824545	C1
727	26	86	S4 mylonitic foliation	271128	6824522	C1
728	25	63	S4 mylonitic foliation	271129	6825158	A
729	33	56	S4 mylonitic foliation	271130	6825390	A
730	22	76	S4 mylonitic foliation	271139	6824894	B
731	28	56	S4 mylonitic foliation	271142	6825122	A
732	5	74	S4 mylonitic foliation	271152	6824610	C1

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fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
733	14	78	S4 mylonitic foliation	271158	6824491	C1
734	180	78	S4 mylonitic foliation	271162	6824105	C2
735	16	78	S4 mylonitic foliation	271165	6824608	C1
736	202	84	S4 mylonitic foliation	271184	6824043	C2
737	3	69	S4 mylonitic foliation	271186	6824644	C1
738	30	86	S4 mylonitic foliation	271187	6824805	C1
739	43	59	S4 mylonitic foliation	271189	6825028	B
740	17	64	S4 mylonitic foliation	271207	6824501	C1
741	215	74	S4 mylonitic foliation	271208	6824728	C1
742	35	85	S4 mylonitic foliation	271218	6824677	C1
743	30	79	S4 mylonitic foliation	271220	6824766	C1
744	45	61	S4 mylonitic foliation	271221	6824972	B
745	16	86	S4 mylonitic foliation	271234	6824502	C1
746	35	68	S4 mylonitic foliation	271236	6824594	C1
747	15	78	S4 mylonitic foliation	271242	6824512	C1
748	38	89	S4 mylonitic foliation	271243	6824707	C1
749	28	78	S4 mylonitic foliation	271251	6824533	C1
750	34	81	S4 mylonitic foliation	271256	6824760	C1
751	32	65	S4 mylonitic foliation	271262	6824549	C1
752	185	88	S4 mylonitic foliation	271263	6823964	C2
753	32	89	S4 mylonitic foliation	271265	6824694	C1
754	24	58	S4 mylonitic foliation	271265	6824539	C1
755	68	66	S4 mylonitic foliation	271271	6824629	C1
756	192	76	S4 mylonitic foliation	271271	6824275	C1
757	14	73	S4 mylonitic foliation	271277	6824309	C1
758	8	79	S4 mylonitic foliation	271278	6824221	C2
759	21	56	S4 mylonitic foliation	271279	6824650	C1
760	55	61	S4 mylonitic foliation	271286	6824916	B
761	211	88	S4 mylonitic foliation	271297	6823882	D
762	182	88	S4 mylonitic foliation	271297	6824376	C1
763	45	66	S4 mylonitic foliation	271297	6824533	C1
764	220	89	S4 mylonitic foliation	271302	6823842	D
765	160	70	S4 mylonitic foliation	271310	6824769	C1
766	32	86	S4 mylonitic foliation	271320	6824496	C1
767	32	86	S4 mylonitic foliation	271320	6824496	C1
768	235	50	S4 mylonitic foliation	271322	6824471	C1
769	235	50	S4 mylonitic foliation	271322	6824471	C1
770	30	73	S4 mylonitic foliation	271330	6824137	C2
771	29	85	S4 mylonitic foliation	271330	6824770	C1
772	29	85	S4 mylonitic foliation	271330	6824770	C1
773	26	89	S4 mylonitic foliation	271340	6824415	C1
774	215	88	S4 mylonitic foliation	271341	6823665	D
775	35	74	S4 mylonitic foliation	271341	6824773	C1
776	220	75	S4 mylonitic foliation	271341	6824773	C1
777	24	90	S4 mylonitic foliation	271342	6824444	C1
778	35	81	S4 mylonitic foliation	271346	6824873	B
779	218	89	S4 mylonitic foliation	271347	6823764	D
780	21	75	S4 mylonitic foliation	271351	6824786	C1
781	35	74	S4 mylonitic foliation	271351	6824775	C1

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fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
782	200	88	S4 mylonitic foliation	271351	6823468	D
783	242	77	S4 mylonitic foliation	271356	6824096	C2
784	19	76	S4 mylonitic foliation	271358	6824796	B
785	185	68	S4 mylonitic foliation	271363	6824433	C1
786	39	80	S4 mylonitic foliation	271366	6824826	B
787	172	69	S4 mylonitic foliation	271370	6824042	C2
788	23	80	S4 mylonitic foliation	271371	6824817	B
789	19	69	S4 mylonitic foliation	271372	6824839	B
790	209	88	S4 mylonitic foliation	271382	6824689	C1
791	18	85	S4 mylonitic foliation	271382	6824447	C1
792	25	61	S4 mylonitic foliation	271384	6824537	C1
793	206	80	S4 mylonitic foliation	271384	6824850	B
794	10	80	S4 mylonitic foliation	271388	6824362	C1
795	31	81	S4 mylonitic foliation	271390	6824472	C1
796	194	84	S4 mylonitic foliation	271393	6824512	C1
797	29	66	S4 mylonitic foliation	271402	6824903	A
798	216	85	S4 mylonitic foliation	271405	6823457	D
799	18	72	S4 mylonitic foliation	271412	6824433	C1
800	26	66	S4 mylonitic foliation	271412	6824797	B
801	19	86	S4 mylonitic foliation	271418	6824445	C1
802	23	70	S4 mylonitic foliation	271418	6824507	C1
803	12	72	S4 mylonitic foliation	271422	6824456	C1
804	30	54	S4 mylonitic foliation	271423	6824767	B
805	28	82	S4 mylonitic foliation	271423	6824463	C1
806	196	88	S4 mylonitic foliation	271425	6825366	A
807	35	89	S4 mylonitic foliation	271426	6824351	C1
808	22	72	S4 mylonitic foliation	271427	6824462	C1
809	12	83	S4 mylonitic foliation	271427	6824471	C1
810	28	89	S4 mylonitic foliation	271434	6824628	C1
811	203	85	S4 mylonitic foliation	271439	6824355	C1
812	19	71	S4 mylonitic foliation	271446	6824880	A
813	27	80	S4 mylonitic foliation	271446	6824666	C1
814	24	64	S4 mylonitic foliation	271449	6824723	C1
815	43	86	S4 mylonitic foliation	271456	6823975	C2
816	188	86	S4 mylonitic foliation	271456	6824670	C1
817	211	48	S4 mylonitic foliation	271459	6823436	D
818	25	76	S4 mylonitic foliation	271461	6824657	C1
819	5	76	S4 mylonitic foliation	271464	6824425	C1
820	31	64	S4 mylonitic foliation	271465	6824865	A
821	25	70	S4 mylonitic foliation	271469	6824695	C1
822	31	63	S4 mylonitic foliation	271471	6824524	C1
823	210	79	S4 mylonitic foliation	271478	6824696	C1
824	15	76	S4 mylonitic foliation	271478	6824696	C1
825	35	85	S4 mylonitic foliation	271480	6824473	C1
826	24	80	S4 mylonitic foliation	271484	6824699	C1
827	34	63	S4 mylonitic foliation	271485	6824872	A
828	24	70	S4 mylonitic foliation	271487	6824701	C1
829	27	80	S4 mylonitic foliation	271488	6824697	C1
830	39	76	S4 mylonitic foliation	271488	6823478	D

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
831	206	74	S4 mylonitic foliation	271489	6823882	C2
832	205	83	S4 mylonitic foliation	271494	6823591	D
833	27	78	S4 mylonitic foliation	271495	6824637	C1
834	266	20	S4 mylonitic foliation	271496	6823505	D
835	23	81	S4 mylonitic foliation	271496	6824715	B
836	20	71	S4 mylonitic foliation	271499	6824704	C1
838	19	74	S4 mylonitic foliation	271505	6824731	B
839	29	79	S4 mylonitic foliation	271506	6824705	C1
840	20	64	S4 mylonitic foliation	271506	6824866	A
841	14	85	S4 mylonitic foliation	271509	6824739	B
842	44	69	S4 mylonitic foliation	271513	6824744	B
843	31	66	S4 mylonitic foliation	271515	6824714	B
844	193	81	S4 mylonitic foliation	271516	6823855	C2
845	28	71	S4 mylonitic foliation	271516	6824723	B
846	24	72	S4 mylonitic foliation	271516	6824751	B
847	28	61	S4 mylonitic foliation	271520	6824790	B
848	13	71	S4 mylonitic foliation	271520	6824858	A
849	25	57	S4 mylonitic foliation	271521	6824844	A
850	256	4	S4 mylonitic foliation	271521	6824773	B
851	6	90	S4 mylonitic foliation	271521	6824773	B
852	206	52	S4 mylonitic foliation	271525	6823415	D
853	15	88	S4 mylonitic foliation	271529	6824830	A
854	19	70	S4 mylonitic foliation	271529	6824830	A
855	55	60	S4 mylonitic foliation	271530	6824781	B
856	27	65	S4 mylonitic foliation	271536	6824820	A
857	208	83	S4 mylonitic foliation	271536	6824620	C1
858	25	61	S4 mylonitic foliation	271542	6824799	B
859	230	69	S4 mylonitic foliation	271558	6823348	D
860	226	84	S4 mylonitic foliation	271558	6823462	D
861	21	65	S4 mylonitic foliation	271561	6824798	B
862	22	58	S4 mylonitic foliation	271565	6824856	A
863	19	85	S4 mylonitic foliation	271571	6824561	C1
864	24	66	S4 mylonitic foliation	271576	6824567	C1
865	25	69	S4 mylonitic foliation	271577	6824812	A
866	45	81	S4 mylonitic foliation	271580	6823520	D
867	31	79	S4 mylonitic foliation	271581	6824598	C1
868	10	75	S4 mylonitic foliation	271581	6824800	A
869	41	80	S4 mylonitic foliation	271585	6823572	D
870	29	79	S4 mylonitic foliation	271589	6824513	C1
871	45	87	S4 mylonitic foliation	271590	6823815	C2
872	12	62	S4 mylonitic foliation	271590	6824798	A
873	15	84	S4 mylonitic foliation	271597	6824286	C1
874	24	79	S4 mylonitic foliation	271599	6824400	C1
875	58	64	S4 mylonitic foliation	271602	6824881	A
876	3	74	S4 mylonitic foliation	271608	6824249	C3
877	220	80	S4 mylonitic foliation	271611	6823704	C2
878	31	76	S4 mylonitic foliation	271623	6824374	C1
879	11	76	S4 mylonitic foliation	271632	6824221	C3
880	40	76	S4 mylonitic foliation	271632	6823567	D

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
881	21	70	S4 mylonitic foliation	271639	6824185	C3
882	220	82	S4 mylonitic foliation	271641	6824345	C1
883	60	87	S4 mylonitic foliation	271642	6823362	D
884	203	86	S4 mylonitic foliation	271652	6824567	C1
885	39	89	S4 mylonitic foliation	271653	6823578	D
886	20	68	S4 mylonitic foliation	271654	6824896	A
887	95	32	S4 mylonitic foliation	271658	6823958	C2
888	197	89	S4 mylonitic foliation	271669	6824147	C3
889	165	83	S4 mylonitic foliation	271671	6823919	C2
890	35	89	S4 mylonitic foliation	271671	6823598	C4
891	20	81	S4 mylonitic foliation	271683	6825310	A
892	60	65	S4 mylonitic foliation	271694	6823661	C2
893	210	77	S4 mylonitic foliation	271698	6823386	D
894	22	75	S4 mylonitic foliation	271700	6824175	C3
895	48	79	S4 mylonitic foliation	271701	6823689	C2
896	20	66	S4 mylonitic foliation	271705	6823888	C2
897	10	69	S4 mylonitic foliation	271716	6824932	A
898	40	80	S4 mylonitic foliation	271723	6823741	C2
899	45	60	S4 mylonitic foliation	271739	6823424	D
900	186	79	S4 mylonitic foliation	271750	6824152	C3
901	65	54	S4 mylonitic foliation	271756	6823885	C2
902	10	76	S4 mylonitic foliation	271764	6824933	A
903	29	78	S4 mylonitic foliation	271768	6824206	C3
904	13	76	S4 mylonitic foliation	271774	6824457	C1
905	206	86	S4 mylonitic foliation	271776	6824069	C3
906	10	60	S4 mylonitic foliation	271777	6824339	C1
907	350	64	S4 mylonitic foliation	271778	6825277	A
908	30	79	S4 mylonitic foliation	271783	6823450	D
909	3	68	S4 mylonitic foliation	271786	6824420	C1
910	45	75	S4 mylonitic foliation	271790	6823469	D
911	128	44	S4 mylonitic foliation	271798	6823974	C2
912	26	71	S4 mylonitic foliation	271814	6824135	C3
913	8	65	S4 mylonitic foliation	271820	6825065	A
914	195	78	S4 mylonitic foliation	271821	6824013	C3
915	12	72	S4 mylonitic foliation	271822	6824148	C3
916	351	69	S4 mylonitic foliation	271827	6825003	A
917	185	84	S4 mylonitic foliation	271832	6823828	C2
918	190	89	S4 mylonitic foliation	271833	6824270	C3
919	28	73	S4 mylonitic foliation	271836	6824249	C3
920	193	78	S4 mylonitic foliation	271848	6824101	C3
921	175	58	S4 mylonitic foliation	271849	6824052	C3
922	12	81	S4 mylonitic foliation	271858	6825121	A
923	187	85	S4 mylonitic foliation	271860	6824293	C1
924	170	76	S4 mylonitic foliation	271864	6824144	C3
925	206	85	S4 mylonitic foliation	271870	6824302	C1
926	355	72	S4 mylonitic foliation	271879	6824343	C1
927	352	70	S4 mylonitic foliation	271890	6825232	A
928	198	86	S4 mylonitic foliation	271895	6824436	C1
929	12	68	S4 mylonitic foliation	271910	6823813	C2

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
930	205	84	S4 mylonitic foliation	271910	6823511	C4
931	8	84	S4 mylonitic foliation	271915	6824399	C1
932	182	85	S4 mylonitic foliation	271915	6824315	C1
933	195	81	S4 mylonitic foliation	271946	6824293	C1
934	10	86	S4 mylonitic foliation	271949	6823515	C4
935	19	64	S4 mylonitic foliation	271950	6824517	B
936	183	80	S4 mylonitic foliation	271961	6824270	C3
937	202	85	S4 mylonitic foliation	271991	6824150	C3
938	13	83	S4 mylonitic foliation	271994	6824560	B
939	154	49	S4 mylonitic foliation	271995	6823573	C4
940	31	67	S4 mylonitic foliation	271997	6823916	C3
941	205	78	S4 mylonitic foliation	271998	6824125	C3
942	17	74	S4 mylonitic foliation	271999	6824186	C3
943	28	55	S4 mylonitic foliation	272012	6823638	C2
944	353	87	S4 mylonitic foliation	272014	6824245	C3
945	156	50	S4 mylonitic foliation	272014	6824043	C3
946	179	82	S4 mylonitic foliation	272015	6824221	C3
947	185	76	S4 mylonitic foliation	272017	6824592	B
948	10	85	S4 mylonitic foliation	272019	6823780	C2
949	170	86	S4 mylonitic foliation	272030	6823993	C3
950	174	86	S4 mylonitic foliation	272034	6823988	C3
951	25	84	S4 mylonitic foliation	272057	6824622	B
952	2	77	S4 mylonitic foliation	272058	6823805	C2
953	20	89	S4 mylonitic foliation	272072	6823832	C2
954	180	67	S4 mylonitic foliation	272073	6823928	C3
955	342	84	S4 mylonitic foliation	272078	6823921	C3
956	181	82	S4 mylonitic foliation	272078	6824002	C3
957	130	24	S4 mylonitic foliation	272082	6823911	C3
958	172	69	S4 mylonitic foliation	272102	6824307	C3
959	9	86	S4 mylonitic foliation	272117	6823799	C2
960	179	88	S4 mylonitic foliation	272124	6824222	C3
961	25	72	S4 mylonitic foliation	272124	6824651	B
962	179	85	S4 mylonitic foliation	272127	6823791	C2
963	135	66	S4 mylonitic foliation	272131	6823581	C4
964	140	35	S4 mylonitic foliation	272137	6823707	C2
965	28	78	S4 mylonitic foliation	272142	6823583	C4
966	155	76	S4 mylonitic foliation	272146	6823654	C4
967	104	49	S4 mylonitic foliation	272147	6823683	C4
968	168	64	S4 mylonitic foliation	272151	6824028	C3
969	189	35	S4 mylonitic foliation	272152	6823977	C3
970	34	75	S4 mylonitic foliation	272153	6824715	A
971	165	37	S4 mylonitic foliation	272164	6823896	C3
972	134	45	S4 mylonitic foliation	272171	6823920	C3
973	155	82	S4 mylonitic foliation	272171	6823557	C4
974	350	66	S4 mylonitic foliation	272178	6823795	C2
975	150	55	S4 mylonitic foliation	272189	6824146	C3
976	5	64	S4 mylonitic foliation	272193	6824174	C3
977	7	75	S4 mylonitic foliation	272194	6824769	A
978	20	65	S4 mylonitic foliation	272209	6823531	C4

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
979	125	64	S4 mylonitic foliation	272227	6823748	C4
980	5	80	S4 mylonitic foliation	272249	6824422	C1
981	92	36	S4 mylonitic foliation	272250	6823695	C4
982	359	84	S4 mylonitic foliation	272255	6823801	C4
983	352	82	S4 mylonitic foliation	272258	6823788	C4
984	165	74	S4 mylonitic foliation	272276	6824441	C1
985	160	62	S4 mylonitic foliation	272278	6824331	C3
986	72	72	S4 mylonitic foliation	272279	6823482	C4
987	30	60	S4 mylonitic foliation	272288	6823818	C2
988	8	73	S4 mylonitic foliation	272289	6824856	A
989	356	78	S4 mylonitic foliation	272302	6824460	C1
990	175	64	S4 mylonitic foliation	272304	6824263	C3
991	165	60	S4 mylonitic foliation	272307	6823462	C4
992	95	28	S4 mylonitic foliation	272307	6823830	C3
993	345	88	S4 mylonitic foliation	272310	6824188	C3
994	35	69	S4 mylonitic foliation	272316	6823864	C3
995	53	75	S4 mylonitic foliation	272317	6824056	C3
996	188	89	S4 mylonitic foliation	272323	6823454	C4
997	162	85	S4 mylonitic foliation	272326	6824003	C3
998	140	60	S4 mylonitic foliation	272332	6823977	C3
999	160	79	S4 mylonitic foliation	272339	6823955	C3
1000	355	85	S4 mylonitic foliation	272343	6824517	B
1001	226	20	S4 mylonitic foliation	272347	6823909	C3
1002	160	88	S4 mylonitic foliation	272354	6823429	C4
1003	150	80	S4 mylonitic foliation	272361	6823796	C4
1004	100	60	S4 mylonitic foliation	272363	6823627	C4
1005	7	68	S4 mylonitic foliation	272373	6824613	A
1006	195	87	S4 mylonitic foliation	272377	6824892	A
1007	112	42	S4 mylonitic foliation	272381	6823748	C4
1008	125	62	S4 mylonitic foliation	272386	6823502	C4
1009	85	65	S4 mylonitic foliation	272410	6824110	C3
1010	3	75	S4 mylonitic foliation	272420	6824654	A
1011	0	90	S4 mylonitic foliation	272436	6823895	C3
1012	5	88	S4 mylonitic foliation	272450	6824797	A
1013	3	78	S4 mylonitic foliation	272455	6824717	A
1014	110	54	S4 mylonitic foliation	272456	6823543	C4
1015	311	86	S4 mylonitic foliation	272456	6824086	C3
1016	100	51	S4 mylonitic foliation	272457	6823697	C4
1017	350	81	S4 mylonitic foliation	272461	6823837	C4
1018	170	78	S4 mylonitic foliation	272466	6823868	C3
1019	70	40	S4 mylonitic foliation	272474	6823828	C4
1020	110	56	S4 mylonitic foliation	272480	6823608	C4
1021	95	43	S4 mylonitic foliation	272490	6823835	C4
1022	297	57	S4 mylonitic foliation	272502	6824078	C3
1023	185	74	S4 mylonitic foliation	272519	6824066	C3
1024	75	72	S4 mylonitic foliation	272540	6824005	C3
1025	354	80	S4 mylonitic foliation	272567	6823796	C4
1026	95	64	S4 mylonitic foliation	272579	6823512	C4
1027	350	72	S4 mylonitic foliation	272598	6823473	C4

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
1028	339	71	S4 mylonitic foliation	272602	6823991	C3
1029	85	62	S4 mylonitic foliation	272604	6823701	C4
1030	343	72	S4 mylonitic foliation	272606	6823741	C4
1031	45	70	S4 mylonitic foliation	272616	6823642	C4
1032	54	73	S4 mylonitic foliation	272619	6823966	C3
1033	126	65	S4 mylonitic foliation	272646	6823458	C4
1034	340	81	S4 mylonitic foliation	272665	6823913	C3
1035	143	58	S4 mylonitic foliation	272684	6823502	C4
1036	130	67	S4 mylonitic foliation	272684	6823889	C4
1037	145	83	S4 mylonitic foliation	272685	6823616	C4
1038	147	62	S4 mylonitic foliation	272690	6823691	C4
1039	39	72	S4 mylonitic foliation	272702	6823635	C4
1040	105	44	S4 mylonitic foliation	272710	6823860	C4
1041	168	68	S4 mylonitic foliation	272725	6823651	C4
1042	335	79	S4 mylonitic foliation	272736	6823827	C4
1043	110	75	S4 mylonitic foliation	272756	6823791	C4
1044	82	57	S4 mylonitic foliation	272797	6823748	C4
1045	150	64	S4 mylonitic foliation	272800	6823653	C4
1046	170	77	S4 mylonitic foliation	272815	6823717	C4
1047	220	84	S4 mylonitic foliation	270940	6824115	D
1048	215	68	S4 mylonitic foliation	270997	6824051	D
1049	212	76	S4 mylonitic foliation	271034	6824002	D
1050	6	81	S4 mylonitic foliation	271047	6823959	D
1051	26	66	S4 mylonitic foliation	271037	6823898	D
1052	225	84	S4 mylonitic foliation	271114	6823906	D
1053	210	64	S4 mylonitic foliation	271248	6823897	D
1054	330	88	S4 mylonitic foliation	272518	6824230	C3
1055	140	57	S4 mylonitic foliation	272472	6824292	C3
1056	139	84	S4 mylonitic foliation	272469	6824312	C3
1057	303	62	S4 mylonitic foliation	272502	6824349	C3
1058	280	64	S4 mylonitic foliation	272503	6824380	C3
1059	175	84	S4 mylonitic foliation	272482	6824415	C3
1060	175	64	S4 mylonitic foliation	272492	6824465	C3
1061	65	79	S4 mylonitic foliation	272467	6824516	C1
1062	356	53	S4 mylonitic foliation	272413	6824560	B
1063	10	76	S4 mylonitic foliation	272239	6824600	B
1064	11	61	S4 mylonitic foliation	272043	6824729	A
1065	336	89	S4 mylonitic foliation	272035	6824783	A
1066	26	82	S4 mylonitic foliation	272061	6824821	A
1067	358	86	S4 mylonitic foliation	272066	6824863	A
1068	3	75	S4 mylonitic foliation	272009	6824918	A
1069	3	85	S4 mylonitic foliation	272018	6824504	B
1070	8	89	S4 mylonitic foliation	271792	6824257	C3
1071	196	88	S4 mylonitic foliation	271167	6823555	D
1072	215	86	S4 mylonitic foliation	271266	6823439	D
1073	25	65	S4 mylonitic foliation	271494	6824998	A
1074	10	67	S4 mylonitic foliation	271469	6825184	A
1075	340	88	S4 mylonitic foliation	272263	6824927	A
1076	172	63	S4 mylonitic foliation	272535	6823359	C4

APPENDIX II: STRUCTURAL MEASUREMENTS IN THE STUDY AREA

fid	Plunge /Dip dir	Plunge/Dip	Structure	X-WGS84UTM34S	Y- WGS84UTM34S	Domain ID
1077	162	83	S4 mylonitic foliation	272073	6823515	C4
1078	184	85	S4 mylonitic foliation	272194	6823440	C4
1079	352	77	S4 mylonitic foliation	272317	6824762	A
1080	19	70	S4 mylonitic foliation	271286	6825616	A

APPENDIX III: DIAMOND DRILL HOLE RESULTS TABLE

Intersection No.	DHID	EOH (m)	Collar coordinates (WGS84UTM34S)		From (m)	To (m)	True width (m)	Intersection weighted average grade		
			X	Y				Li2O (%)	Nb2O5 (ppm)	Ta2O5 (g/t)
1	D1DDH01	20.87	271546	6824558	3.63	7.76	4.09	0.80	87	228
2	D1DDH01	20.87	271546	6824558	13.05	16.65	3.57	0.39	81	347
3	D1DDH01	20.87	271546	6824558	16.89	18.05	1.15	0.01	55	717
4	D1DDH02	20.73	271513	6824541	2.21	6.08	3.83	0.11	95	339
5	D1DDH02	20.73	271513	6824541	11.61	12.42	0.80	0.19	101	327
6	D1DDH02	20.73	271513	6824541	12.57	13.16	0.58	0.11	52	648
7	D1DDH02	20.73	271513	6824541	14.17	15.04	0.86	0.07	88	369
8	D1DDH03	33.19	271452	6824648	8.47	15.7	7.16	0.01	120	398
9	D1DDH03	33.19	271452	6824648	25.19	29.37	4.14	0.01	49	325
10	D1DDH04	27.68	271549	6824648	10.75	12.16	1.40	0.01	72	350
11	D1DDH04	27.68	271549	6824648	20.9	27.09	6.13	0.01	67	288
12	D1DDH05	30.41	271507	6824650	4.08	9.33	5.20	0.01	86	458
13	D1DDH05	30.41	271507	6824650	25.52	28.94	3.39	0.02	106	396
14	D1DDH06	21.31	271507	6824605	1.54	9.53	7.91	0.42	82	317
15	D1DDH06	21.31	271507	6824605	13.02	16.03	2.98	0.33	65	244
16	D1DDH06	21.31	271507	6824605	18.18	19.1	0.91	0.03	82	214
17	D1DDH07	21.51	271559	6824613	0	8.67	8.59	0.02	71	169
18	D1DDH07	21.51	271559	6824613	16.21	17.5	1.28	0.01	56	253
19	D1DDH08	8.09	271590	6824608	1.5	2.73	1.22	0.01	63	413
20	D1DDH08	8.09	271590	6824608	7.8	8.09	0.29	0.09	136	357
21	D1DDH09	29.99	271616	6824573	5.04	5.77	0.72	0.01	28	279
22	D1DDH09	29.99	271616	6824573	9.58	19.13	9.46	0.23	65	280
23	F1DDH02	11.67	272051	6823952	5.89	8.14	2.16	0.29	55	343
24	F1DDH03	11.31	272099	6823954	9.71	10.78	1.03	0.01	54	507
25	F1DDH04	7.89	272002	6823945	2.7	4.82	2.04	0.02	26	421
26	F1DDH05	12.2	272003	6824003	9.3	11.97	2.57	0.01	46	309
27	F1DDH06	7.73	272153	6823954	3.76	5.18	1.37	0.02	44	399
28	F1DDH07	12.14	272044	6824008	6.24	8.44	2.12	0.01	40	275

APPENDIX III: DIAMOND DRILL HOLE RESULTS TABLE

Intersection No.	DHID	EOH (m)	Collar coordinates (WGS84UTM34S)		From (m)	To (m)	True width (m)	Intersection weighted average grade		
			X	Y				Li2O (%)	Nb2O5 (ppm)	Ta2O5 (g/t)
29	F1DDH08	11	272005	6824038	6.33	9.37	2.92	0.01	53	459
30	F1DDH09	12.39	272050	6823901	10.38	11.89	1.45	0.01	46	665
31	F1DDH10	7.33	272055	6823982	0.23	2.88	2.55	0.01	36	272
32	F1DDH11	4.36	272104	6823901	1.06	2.93	1.80	0.02	99	618
33	F1DDH12	14.13	272054	6824042	3.68	6.24	2.46	0.01	54	363
34	F1DDH12	4.97	272099	6824103	7.85	8.28	0.41	0.02	45	443
35	F1DDH13	9.25	272002	6823901	0.43	2.59	2.08	0.00	51	361
36	F1DDH16	9.7	272080	6824169	5.33	7.1	1.70	0.01	62	519
37	DP01	30.05	271899	6823998	2.81	3.39	0.56	0.00	60	652
38	DP01	30.05	271899	6823998	26.37	28.53	2.08	0.01	59	505
39	DP02	32.77	271952	6824049	0.00	0.10	0.10	0.04	30	400
40	DP02	32.77	271952	6824049	1.20	1.79	0.57	0.01	36	488
41	DP02	32.77	271952	6824049	9.52	11.38	1.79	0.86	58	476
42	DP03	5.75	271995	6824097	0.25	2.68	2.34	0.00	38	452
43	DP04	42.74	271851	6824051	16.57	17.79	1.17	0.01	90	884
44	DP04	42.74	271851	6824051	28.33	29.25	0.88	0.00	59	854
45	DP04	42.74	271851	6824051	36.25	37.43	1.13	0.00	77	782
46	DP05	41.87	271902	6824117	27.83	28.38	0.53	0.01	40	355
47	DP05	41.87	271902	6824117	30.21	32.23	1.94	0.00	71	745
48	DP06	51.05	271953	6824161	44.29	46.93	2.54	0.01	44	568
49	DP07	57.25	271992	6824217	52.33	54.03	1.63	0.05	87	649
50	DP08	20.53	271799	6824054	1.08	1.32	0.23	0.51	44	161
51	DP08	20.53	271799	6824054	2.42	2.53	0.11	0.18	13	125
52	DP09	18.75	271742	6824045	9.81	11.21	1.35	0.01	57	655
53	DP10	25.11	271795	6824104	16.54	19.01	2.37	0.20	62	619
54	DP11	92.52	271898	6824194	6.64	6.79	0.14	0.09	20	359
55	DP11	92.52	271898	6824194	42.28	44.89	2.51	0.01	57	750
56	DP11	92.52	271898	6824194	48.00	48.60	0.58	0.01	51	484

APPENDIX III: DIAMOND DRILL HOLE RESULTS TABLE

Intersection No.	DHID	EOH (m)	Collar coordinates (WGS84UTM34S)		From (m)	To (m)	True width (m)	Intersection weighted average grade		
			X	Y				Li2O (%)	Nb2O5 (ppm)	Ta2O5 (g/t)
57	DP11	92.52	271898	6824194	61.92	62.35	0.41	0.02	47	556
58	DP11	92.52	271898	6824194	69.21	69.54	0.32	0.02	37	454
59	DP11	92.52	271898	6824194	69.86	69.96	0.10	0.02	5	187
60	DP11	92.52	271898	6824194	75.96	76.16	0.19	0.02	64	382
61	DP12	56.98	271943	6824245	50.23	51.73	1.44	0.02	67	643
62	DP12	56.98	271943	6824245	51.96	52.07	0.11	0.00	40	380
63	DP13	13.82	272049	6824145	7.92	10.22	2.21	0.00	57	619
64	DP14	21.23	271753	6824101	7.66	9.37	1.64	0.87	67	704
65	DP14	21.23	271753	6824101	15.10	15.95	0.82	0.01	35	376
66	DP14	21.23	271753	6824101	19.78	20.85	1.03	0.01	34	365
67	DP15	21.87	271799	6824128	13.72	17.34	3.48	0.01	49	479
68	DP16	35.07	271738	6824161	20.93	21.78	0.82	0.02	29	441
69	DP17	37.67	271805	6824195	10.8	10.95	0.14	0.06	6	413
70	DP17	37.67	271805	6824195	23.33	25.22	1.82	0.14	50	553
71	DP17	37.67	271805	6824195	30.66	32.44	1.71	0.01	50	731
72	DP18	134.81	271698	6824149	4.48	5.38	0.87	0.01	82	342
73	DP18	134.81	271698	6824149	6.32	6.51	0.18	0.00	17	131
74	DP18	134.81	271698	6824149	20.51	20.78	0.26	0.05	102	330
75	DP18	134.81	271698	6824149	35.45	36.00	0.53	0.01	40	177
76	DP18	134.81	271698	6824149	80.96	81.11	0.14	0.03	16	206
77	DP18	134.81	271698	6824149	118.68	118.85	0.16	0.03	53	321
78	DP18	134.81	271698	6824149	131.43	131.98	0.53	0.03	57	266
79	DP19	49.04	271751	6824185	15.32	15.49	0.16	0.06	26	432
80	DP19	49.04	271751	6824185	24.83	24.91	0.08	0.24	11	386
81	DP20	15.98	271701	6824200	2.89	5.97	2.96	0.01	54	614
82	DP20	15.98	271701	6824200	6.73	7.04	0.30	0.01	48	732
83	DP20	15.98	271701	6824200	13.36	13.90	0.52	0.03	9	988
84	DP21	121.04	271661	6824197	5.49	8.49	2.88	0.01	82	454

APPENDIX III: DIAMOND DRILL HOLE RESULTS TABLE

Intersection No.	DHID	EOH (m)	Collar coordinates (WGS84UTM34S)		From (m)	To (m)	True width (m)	Intersection weighted average grade		
			X	Y				Li2O (%)	Nb2O5 (ppm)	Ta2O5 (g/t)
85	DP21	121.04	271661	6824197	23.04	23.53	0.47	0.03	49	612
86	DP21	121.04	271661	6824197	62.82	62.95	0.12	0.08	24	189
87	DP22	37.67	271849	6824233	32.82	35.01	2.11	0.01	84	762
88	DP23	14.79	272117	6824149	8.79	10.21	1.37	0.00	54	674
89	DP23	14.79	272117	6824149	10.37	10.5	0.12	0.01	19	421
90	DP24	48.25	271645	6824535	27.38	37	9.53	0.53	90	354
91	DP25	58.52	271583	6824530	28	31.59	3.56	0.26	26	233
92	DP25	58.52	271583	6824530	39.88	43.36	3.45	0.02	126	403
93	DP25	58.52	271583	6824530	44.1	44.24	0.14	0.45	88	474
94	DP25	58.52	271583	6824530	44.61	47.69	3.05	0.43	52	368
95	DP25	58.52	271583	6824530	49.09	49.43	0.34	0.09	42	660
96	DP26	52.83	271546	6824512	16.11	19.81	3.67	0.02	20	193
97	DP26	52.83	271546	6824512	31.91	35.16	3.22	0.27	87	304
98	DP26	52.83	271546	6824512	35.25	35.35	0.10	0.19	16	808
99	DP26	52.83	271546	6824512	35.74	36.52	0.77	0.73	44	684
100	DP26	52.83	271546	6824512	42.09	45.35	3.23	0.01	48	497
101	DP26	52.83	271546	6824512	48.55	49.07	0.52	0.01	67	451
102	DP27	14.84	272085	6824174	7.07	8.43	1.31	0.01	53	578
103	DP28	43.67	272094	6824316	24.56	24.93	0.36	0.02	58	603
104	DP29	21.07	272113	6824201	15.12	16.34	1.17	0.01	46	624