Natural Resources Canada | Ressources naturelles Canada

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 8133

2016 Report of field activities in the Dunite Peak area, Big Salmon Range, south central Yukon: GEM2 Cordillera Project

A.J. Parsons, J.J. Ryan, M. Coleman, and C. van Staal

2016

Canada

GEOLOGICAL SURVEY OF CANADA
OPEN FILE 8133

2016 Report of field activities in the Dunite Peak area, Big Salmon Range, south central Yukon: GEM2 Cordillera Project

A.J. Parsons[1], J.J. Ryan[1], M. Coleman[2], and C. van Staal[1]

[1] Geological Survey of Canada, 1500-605 Robson Street, Vancouver, British Columbia
[2] Department of Earth Sciences, Simon Fraser University, 8888 University Drive, Burnaby, British Columbia

2016

doi:10.4095/299243

This publication is available for free download through GEOSCAN (http://geoscan.nrcan.gc.ca/).

Recommended citation
Parsons, A.J., Ryan, J.J., Coleman. M., and van Staal, C., 2016. 2016 Report of field activities in the Dunite Peak area, Big Salmon Range, south central Yukon: GEM2 Cordillera Project; Geological Survey of Canada, Open File 8133, 7 p. doi:10.4095/299243

Publications in this series have not been edited; they are released as submitted by the author.

Foreword

The Geo-mapping for Energy and Minerals (GEM) program is laying the foundation for sustainable economic development in the North. The Program provides modern public geoscience that will set the stage for long-term decision making related to investment in responsible resource development. Geoscience knowledge produced by GEM supports evidence-based exploration for new energy and mineral resources and enables northern communities to make informed decisions about their land, economy and society. Building upon the success of its first five-years, GEM has been renewed until 2020 to continue producing new, publically available, regional-scale geoscience knowledge in Canada's North.

During the summer 2016, GEM program has successfully produced 23 activity reports that include geological, geochemical and geophysical surveying. These activities have been undertaken in collaboration with provincial and territorial governments, northerners and their institutions, academia and the private sector. GEM will continue to work with these key collaborators as the program advances.

Project Summary

This open file report outlines the 2016 field activities conducted around Dunite Peak, Big Salmon Range, Yukon (Fig. 1), as part of the Geo-mapping for Energy and Minerals (GEM) program. Geological mapping and sampling were conducted to understand process responsible for formation of the NW Cordillera. The NW Cordillera is composed of multiple crustal blocks which formed volcanic islands west of the North American continent between Devonian and Jurassic periods. These islands were separated from the continent by the Slide Mountain Ocean. During Triassic – Cretaceous periods, these islands or 'terranes' collided with North America to produce the NW Cordilleran mountain belt. In the Dunite Peak area, remnants of oceanic rocks belonging to the Slide Mountain Ocean are preserved on top of the Yukon-Tanana terrane. This study will examine the structural relationships between Slide Mountain and Yukon-Tanana terranes to understand the early formation of the Slide Mountain Ocean and the deformation processes that accompanied the closure of this ocean and its collision with North America.

1. Introduction

The NW Cordillera (Fig. 2) is composed of multiple terranes that record a complex and protracted geological history spanning 1.8 billion years, including the time prior to and during their accretion to the

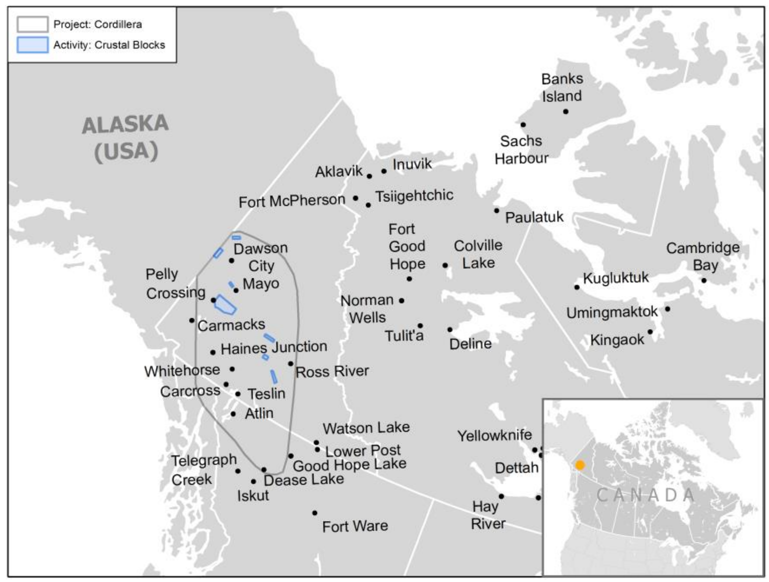

Figure 1. Overview map illustrating the footprint of the Cordillera project. Footprint of the Crustal Blocks activity is highlighted in blue.

North American continent (Nelson *et al.* 2013). Determination of the timing and kinematics of terrane accretion is fundamental to our understanding of the NW Cordillera and of accretionary orogens in general.

Such understanding can be gained through targeted, integrated geochronological, thermobarometric and structural studies (PTtD studies – Pressure, Temperature, time, Deformation) of terrane interactions (e.g. Berman *et al.* 2007). Here, we present the preliminary findings from the 2016 field campaign , which form the groundwork for a detailed PTtD study of the timing and kinematics of accretion of the Slide Mountain terrane (SMT), the peri-Laurentian Yukon-Tanana terrane (YTT), and the parautochthonous Cassiar terrane (CT; Fig. 2) (e.g. Nelson *et al.* 2013).

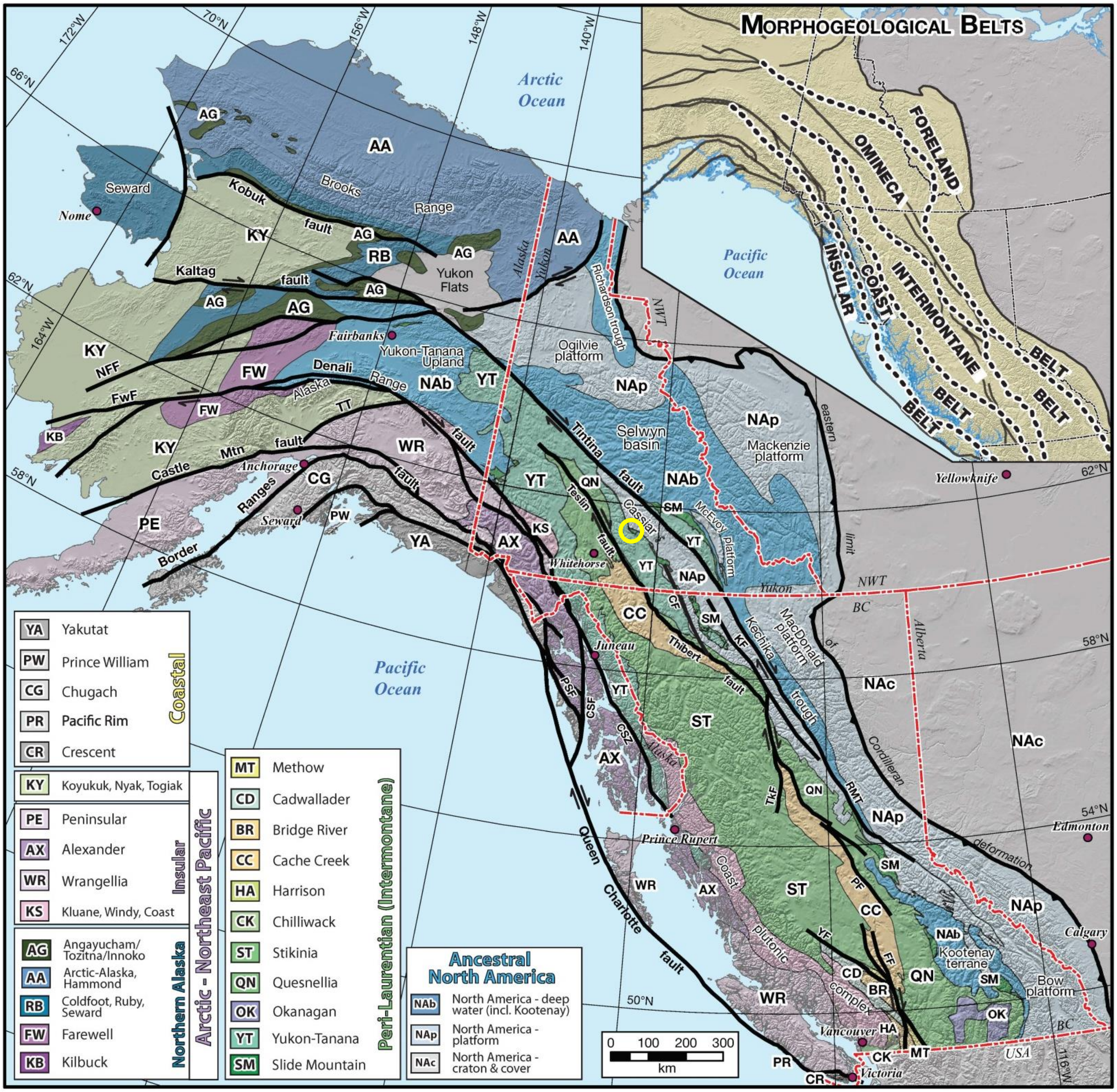

Figure 2. Terrane map of the NW Corrdillera (from Nelson et al. 2013). Dunite Peak area highlighted by yellow circle. Cassiar Terrane is part of North America – platform (Nap).

The Slide Mountain terrane (SMT) is an oceanic terrane comprising chert, mid-ocean ridge basalt (MORB), gabbro, serpentinized mantle peridotite and associated marine sedimentary rocks (Struik & Orchard 1985; Nelson 1993; Nelson *et al.*, 2013). The type section for SMT is Sliding Mountain, northern British Columbia (BC) (Orchard & Struik 1985; Struik & Orchard 1985; Nelson *et al.* 2013).

The SMT outcrops in SE and north-central BC and in south-central Yukon (Fig. 2), and typically forms either isolated klippen *overlying* peri-Laurentian / parautochthonous terranes, or thrust bound enclaves within peri-Laurentian / parautochthonous terranes (e.g. Tempelman-Kluit 1979; Erdmer 1985; Struik & Orchard 1985; Nelson 1993; de Keijzer *et al.* 1999; Fallas *et al.* 1999; Colpron *et al.* 2005; Colpron *et al.* 2006; Nelson *et al.* 2013; Petrie *et al.* 2015; Colpron *et al.* 2016; Isard *et al.* 2016).

In our study, we have selected the Dunite Peak area of the Big Salmon Range, south-central Yukon (Tempelman-Kluit 1979; de Keijzer *et al.* 1999; Colpron *et al.* 2005) as a favourable location to investigate the PTtD evolution of the SMT and its interaction with the peri-Laurentian /

parautochthonous terranes during the formation of the NW Cordillera. The geology of the Dunite Peak area is characterised by two klippe of mafic-ultramafic assemblages overlying metasedimentary rocks belonging to the YTT and/or CT (Tempelman-Kluit 1979; de Keijzer *et al.* 1999; Colpron *et al.* 2016). The high elevation and exceptionally well-exposed terrain allows for multiple foot traverses through vertical structural transects of both klippen that extend from the underlying YTT / CT basement rocks through the entire sequence of metasedimentary rocks and into the overlyingmafic-ultramafic assemblages of the SMT. Importantly, these traverses provide unparalleled exposure of, and access to, the SMT – YTT terrane boundary, making the Dunite Peak area an ideal location for a targeted PTtD study of terrane interactions at a multitude of temporal and spatial scales during the NW Cordilleran orogeny.

2. Methods

Initial reconnaissance of the study area was conducted over two days by AJP, JJR and CVS via helicopter-assisted spot checks of key locations. Following this, AJP and MC conducted 15 days fieldwork across the study area, staged from 3 different fly-camps. The primary fieldwork objectives were: (*a*) bedrock lithology identification and determination of a recognisable and mappable stratigraphy (Fig. 3); (*b*) collection of structural and kinematic data; and (*c*) collection of samples for petrological, microstructural, thermobarometric, geochemical and geochronological analyses. A total of 135 samples were collected from 206 stations. In addition to mapping on 1:20000 scale field slips, station waypoints, structural data, photographs and samples were also digitally recorded and geospatially referenced using the GSC field data collection system (GanFeld) on a ruggedized handheld computer. The preliminary 1:20,000 scale map (Fig. 4) was constructed using ArcGIS 10.2, drawn from digitised and geospatially referenced copies of field slips. Note that this is a 'work-in-progress' map and the final draft is likely to differ after the use of structure contours (Bennison *et al.* 2013) and cross section construction to better constrain unit boundaries.

3. Results

3.1. Stratigraphy

Through detailed mapping of the ultramafic klippe and metasedimentary rock, we have determined a recognisable lithostratigraphic framework (Figs 3 and 4) that can be applied to the whole of the study area. This frame work is described in order of relative structural position from the lowermost to highest unit.

3.1.1. Unit Sc1: Interbedded marble and metapelitic schist

Unit Sc1 is the structurally lowest unit, composed of marble interbedded with subordinate metapelitic (biotite + quartz ± feldspar ± garnet) schist(Fig.3a). The base of Unit Sc1 was not observed and in most cases only the top of this unit was directly mapped due to limited exposure and difficult access near the valley bottoms. This unit is currently mapped within the Snowcap assemblage of the YTT (Colpron *et al.* 2006; Colpron *et al.* 2016).

3.1.2. Unit Sc/F2a: Micaceous quartzite

Unit Sc/F2a comprises grey-brown micaceous quartzite with subordinate carbonaceous pelitic layers (Fig. 3b). The basal contact with the underlying marble and schist of Unit Sc1 is not observed and it is unclear if the boundary between these units is a stratigraphic or structural. Unit Sc/F2a is currently mapped as part of the Finlayson assemblage of the YTT (Colpron *et al.* 2006; Colpron *et al.* 2016).

3.1.3. Unit Sc/F2b: Interbedded quartzite and marble

Unit Sc/F2b comprises a lower assemblage of white quartzite, overlain by an upper assemblage of interbedded quartzite and marble. The basal contact with the underlying micaceous quartzite in Units Sc/F2a is not observed, however, the style of deformation and recrystallized appearance of quartzites within these units is sufficiently similar to suggest that Unit Sc/F2a and Sc/F2b derive from a single stratigraphic sedimentary sequence. At present rocks in Unit Sc/F2b are assigned to the Finlayson assemblage (Colpron *et al.* 2006; Colpron *et al.* 2016).

3.1.4. Unit F3: Quartz-mica-schist

Unit F3 is the structurally highest metasedimentary unit and directly underlies the mafic-ultramafic klippen. It comprises a highly sheared carbonaceous quartz-mica-schist with a strong mylonitic foliation (Fig. 3c-d). The basal contact with the underlying interbedded quartzite and marble unit (Unit ScF2b) is not observed and it is not clear whether these units are part of the same sedimentary sequence or whether a structural discontinuity exists between them. At present, this unit is mapped within the Finlayson assemblage (Colpron *et al.* 2006; Colpron *et al.* 2016).

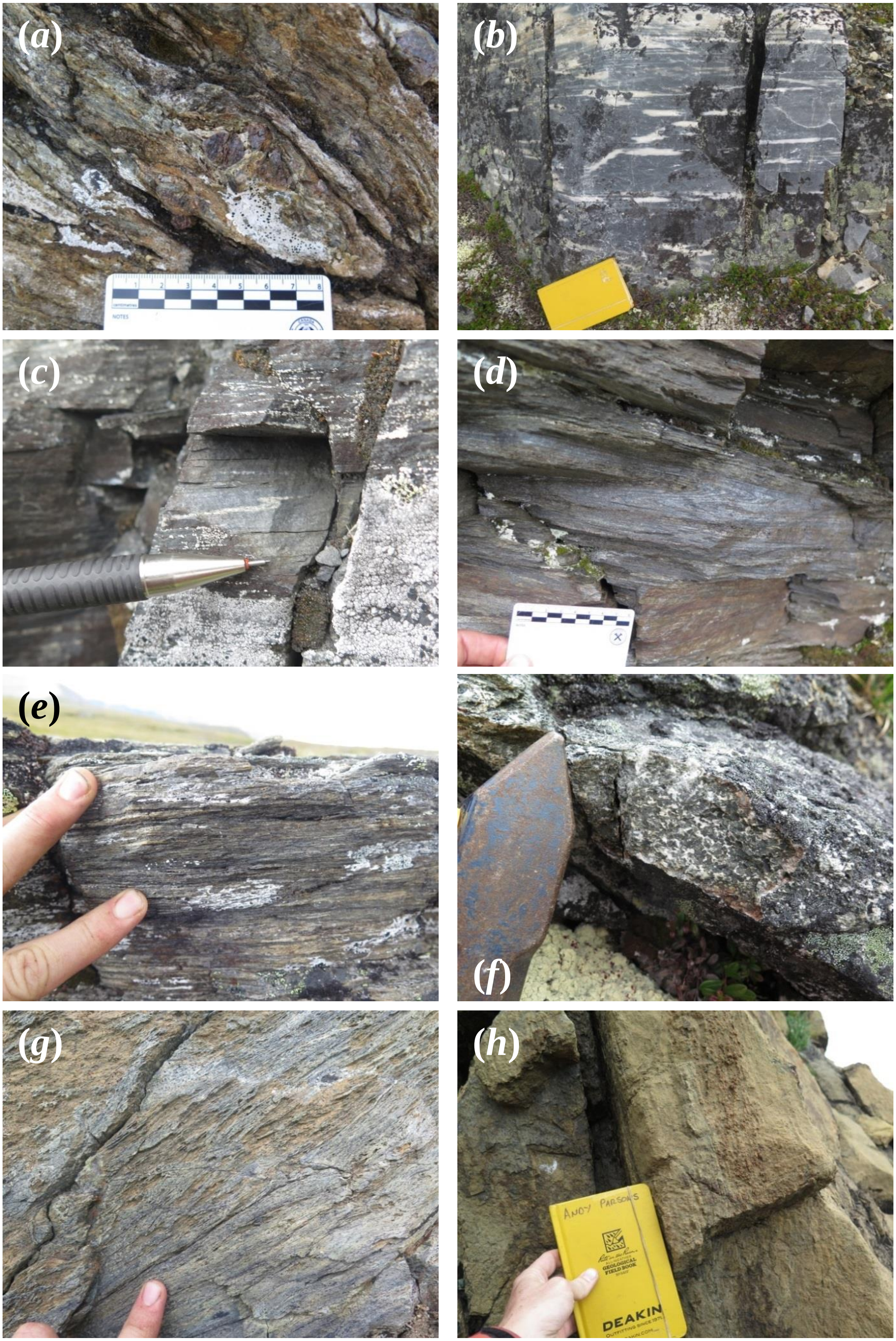

Figure 3. (a) Unit Sc1 – Garnet-mica-schist with rotated garnet porphyroblasts. (b) Unit Sc/F2b – Quartzite with sheared quartz veins. (c-d) Unit F3 – quartz-mica-schist with intrafolia folds and shear fabric. (e) Unit SM4 – Fine-grained metagabbro. (f) Unit SM4 – Coarse-grained leucogabbro. (g) Unit SM5a – Sheared serpentinite. (h) Unit SM5b – foliated serpentinized harzburgite.

3.1.5. Unit SM4: Metagabbro, leucogabbro and greenschist

Unit SM4 contains a lower portion of fine grained, chloritic metagabbro and greenschist (Fig. 3e) and an upper portion of coarse grained metagabbro, leucogabbro (Fig. 3f) and subordinate felsic sills and pyroxenite. The base of Unit SM4 is rarely observed on the eastern klippe (Fig. 4) and forms a ductile sheared contact with the underlying quartz-mica-schist. Unit SM4 is considered part of the Slide Mountain terrane (Colpron *et al.* 2006; Colpron *et al.* 2016).

3.1.6. Unit SM5a: Serpentinite

Unit SM5a is occurs in the basal section of ultramafic sequence and is composed of distinct, highly deformed blue-green and dark-blue-black 'fish-scale' serpentinite (Fig. 3g). The basal contact forms a sheared structural discontinuity with the underlying metagabbro (Unit SM4). This unit forms part of the Slide Mountain terrane (Colpron *et al.* 2006; Colpron *et al.* 2016).

3.1.7. Unit SM5b: Serpentinized harzburgite and dunite

Unit SM5b is the structurally highest unit in the study area and comprises variably serpentinized harzburgite and dunite (Fig.3h). Deformation within this unit is confined to the basal section, where changes in colour, corresponding to different degrees of serpentinization, highlight fault bound enclaves. The basal contact with the underlying serpentinite is a 1-5 m thick, diffuse zone of shearing characterised by S-C fabrics and cataclasite. Unit SM5b is part of the Slide Mountain terrane (Colpron *et al.* 2006; Colpron *et al*. 2016).

4. Geological map

Based on the outlined lithostratigraphy, a new geological map has been constructed for the dunite peak area. Initial findings indicate that the regional structure is defined by an open synform with an ENE-WSW trending axial trace, plunging gently to the west. Macrostructural analysis has also lead to the identification of several shear zones. Shear fabrics, mylonitic fabrics and folding within the quartz-mica-schist of Unit F3 and metagabbro and greenschist at the base of Unit SM4 suggest that the boundary between these units corresponds to an important structural discontinuity, which may define the Slide Mountain – Yukon-Tanana terrane boundary (Fig. 4). Additionally, the basal serpentinite layer of the ultramafic sequence (Unit SM5a) forms a shear zone between the mantle peridotites (Unit SM5) and underlying gabbroic rocks (Unit SM4) (Fig. 4).

5. Conclusion & future work

Fieldwork in the Dunite Peak area has resulted in the construction of a new geological map for the area, based on recognition of a mappable bedrock lithostratigraphy. Major shear zones have been identified between Units SM5 and SM4 and between Units SM4 and F3. The latter may correspond to the Slide Mountain – Yukon-Tanana terrane boundary. The regional structure is defined by an open, west plunging ENE-SWS striking synform.

Future work will focus on determining the kinematic evolution of the SMT from its original tectonic setting to emplacement over the YTT, through refinement of the new map and cross section construction to better constrain the regional structure and its kinematic evolution. This will be followed by detailed analyses of the collected samples in order to work out the PTtD evolution of the SMT and YTT in this region. These analyses will include: optical and electron microscopy, thermobarometry, in-situ Ar/Ar geochronology of deformation microstructures to determine the timing of shearing, U-Pb zircon geochronology to determine the age of formation of the gabbroic rocks of Slide Mountain terrane, and geochemical analysis of mafic and ultramafic rocks to constrain the litho-tectonic origin.

Acknowledgments

We thank Dejan Milidragovic for reviewing this report. Delmar Washington, Melvin Lagersson and Chris Salyniuk of Capital Helicopters (1995) Inc. provided excellent flight services. Members of the Yukon Geological Survey provided logistical support during fieldwork. We thank Steve Williams for pre-field and post-field digital data and information management. The project was funded by the Geological Survey of Canada's Geomapping for Energy and Minerals program, with support from the Yukon Geological Survey.

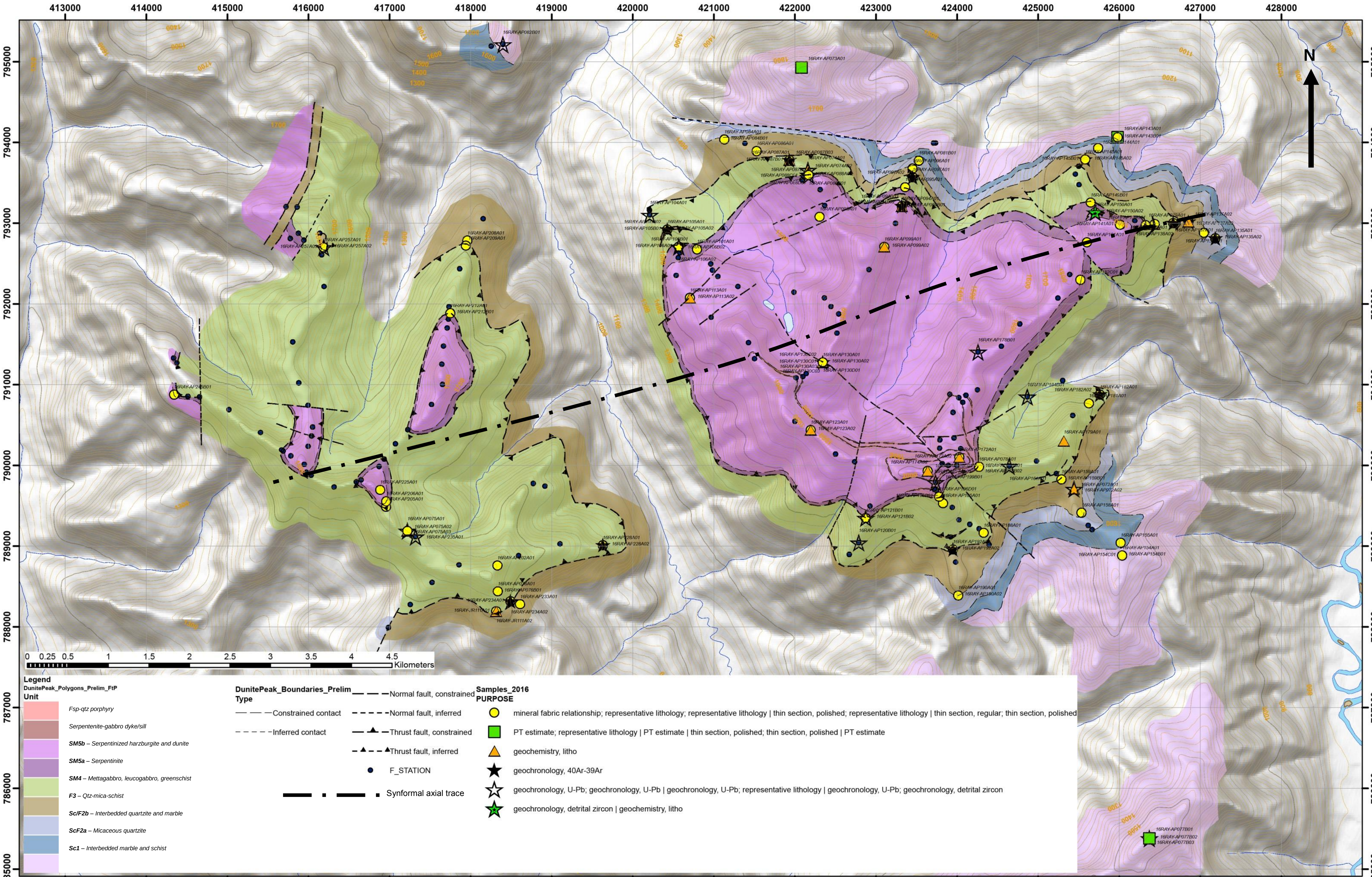

Figure 4. Geological map of the Dunite Peak area.

References

Bennison, G.M., Olver, P.A., Moseley, K.A. (2013). *An introduction to geological structures and maps*. New York, USA, Routledge.

Berman, R.G., Ryan, J.J., Gordey, S.P., Villeneuve, M. (2007). Permian to Cretaceous polymetamorphic evolution of the Stewart River region, Yukon-Tanana terrane, Yukon, Canada: P–T evolution linked with in situ SHRIMP monazite geochronology. *Journal of Metamorphic Geology.* 25, 803-827.

Colpron, M., Gladwin, K., Johnston, S.T., Mortensen, J.K., Gehrels, G.E. (2005). Geology and juxtaposition history of the Yukon-Tanana, Slide Mountain, and Cassiar terranes in the Glenlyon area of central Yukon. *Canadian Journal of Earth Sciences.* 42, 1431-1448.

Colpron, M., Nelson, J., Murphy, D.C. (2006). A tectonostratigraphic framework for the pericratonic terranes of the northern Canadian Cordillera. *In*. Colpron, M., Nelson, J. (*eds.*) *Paleozoic evolution and metallogeny of pericratonic terranes at the ancient Pacific margin of North America, Canadian and Alaskan Cordillera: Geological Association of Canada Special Paper*. 45**,** 1-23.

Colpron, M., Israel, S., Murphy, D., Pigage, L., Moynihan, D. (2016). Yukon bedrock geology map. *Open File 2016-1, scale 1:1000,000, map and legend.*

De Keijzer, M., Williams, P.F., Brown, R.L. (1999). Kilometre-scale folding in the Teslin zone, northern Canadian Cordillera, and its tectonic implications for the accretion of the Yukon-Tanana terrane to North America. *Canadian Journal of Earth Sciences.* 36, 479-494.

Erdmer, P. (1985). An examination of the cataclastic fabrics and structures of parts of Nisutlin, Anvil and Simpson allochthons, central Yukon: test of the arc-continent collision model. *Journal of Structural Geology.* 7, 57-72.

Fallas, K., Erdmer, P., Creaser, R., Archibald, D., Heaman, L. (1999). New terrane interpretation for the St. Cyr klippe, south-central Yukon. *LITHOPROBE SNORCLE Transect Meeting Report.* 130-137.

Isard, S.J., Gilotti, J.A., Mcclelland, W.C., Petrie, M.B., Van Staal, C.R. (2016). Geology and U-Pb geochronology of low-grade mafic ricks from St. Cyr klippe and a marble from the footwall, Canadian Cordillera, Yukon. *Geological Survey of Canada.* Current Research 2016-1, 22.

Nelson, J., Colpron, M., Israel, S. (2013). The Cordillera of British Columbia, Yukon, and Alaska: Tectonics and metallogeny. *Tectonics, Metallogeny, and Discovery: The North American Cordillera and Similar Accretionary Settings: Society of Economic Geologists Special Publication.* 17, 53-109.

Nelson, J.L. (1993). The Sylvester Allochthon: upper Paleozoic marginal-basin and island-arc terranes in northern British Columbia. *Canadian Journal of Earth Sciences.* 30, 631-643.

Orchard, M.J., Struik, L.C. (1985). Conodonts and stratigraphy of upper Paleozoic limestones in Cariboo gold belt, east-central British Columbia. *Canadian Journal of Earth Sciences.* 22, 538-552.

Petrie, M.B., Gilotti, J.A., Mcclelland, W.C., Van Staal, C., Isard, S.J. (2015). Geologic Setting of Eclogite-facies Assemblages in the St. Cyr Klippe, Yukon–Tanana Terrane, Yukon, Canada. *Geoscience Canada.* 42, 327-350.

Struik, L.C., Orchard, M.J. (1985). Late Paleozoic conodonts from ribbon chert delineate imbricate thrusts within the Antler Formation of the Slide Mountain terrane, central British Columbia. *Geology.* 13, 794-798.

Tempelman-Kluit, D.J. (1979). Transported cataclasite, ophiolite, and granodiorite in Yukon: Evidence of arc-continent collision. *Geological Survey of Canada Paper.* 79-14, 27.