GS2020-3

Investigation of zirconium- and light rare-earth element–enriched rocks in drillcore from the Huzyk Creek property, sub-Phanerozoic Kisseynew domain, central Manitoba (NTS 63J6)

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In Brief:

- A study was initiated to investigate an occurrence of hornblende granite in drillcore at the Huzyk Creek property, which is enriched in Ba, Sr, Zr, and light rare-earth elements
- The hornblende granite could be related to A-type granite magmatism or post-orogenic alkaline-affinity magmatism
- There could be potential for Zr and/or rare-earth element mineralization in the area; however, further study is required

Citation:

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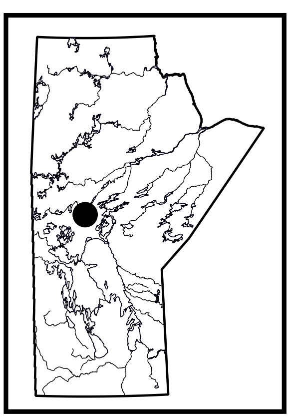

Summary

A study was initiated to investigate an occurrence of hornblende granite in drillcore at the Huzyk Creek property. It is enriched in Ba, Sr, Zr and light rare-earth elements, and may be metasomatized. The hornblende granite is hosted in interlayered hornblende gneiss and calcsilicate rock that is interpreted as metamorphosed and variably altered mafic rock. The hornblende granite occurs as relatively small dikes (<10 m) that contain hornblende, biotite, titanite and sulphide. Two additional rock types that could be metasomatic phases were identified: 1) sulphide- and titanite-rich calcsilicate, and 2) bleached rock. The sulphide- and titanite-rich calcsilicate is texturally and mineralogically variable, and may have multiple origins. Only one example of the bleached rock was identified and it appears to crosscut fabrics and structures in the hostrock. Further work is required to determine the affinity of the hornblende granite and the significance of the sulphide- and titanite-rich calcsilicate and bleached rock. The hornblende granite could be related to A-type granite magmatism or postorogenic alkaline-affinity magmatism. If either of these scenarios is confirmed, it could indicate potential for Zr, Nb, Y and/or rare-earth element mineralization in the area.

Introduction

A project was initiated in 2019 to investigate the origins of V-enriched graphite mineralization in drillcore from the Huzyk Creek property (Beaumont-Smith, 2018; Couëslan, 2019, 2020; Vanadian Energy Corp., 2019). During this investigation, a sample of (possibly metasomatized) granite from drillcore HZ-19-1 was found to contain elevated concentrations of Ba, Sr, Zr and light rare-earth elements (LREE; Couëslan, 2020). A new study was initiated in 2020 to determine the extent and nature of the enriched rocks. During the 2019 investigation, the drillcore was logged by attempting to discern the original protolith of the high-grade gneisses through the metamorphic and magmatic overprint. In 2020, a portion of drillcore HZ-19-1 was revisited to look specifically at intrusive phases and possible metasomatic overprint.

Regional geology

Although the Huzyk Creek property overlies the boundary between the Thompson nickel belt and the Kisseynew domain, the stratigraphy, lithogeochemistry and Sm-Nd isotope geochemistry indicate that drillholes HZ-19-1 and HZ-19-2 intersect rocks of the sub-Phanerozoic Kisseynew domain (Figure GS2020-3-1; Couëslan, 2020). The Kisseynew domain is situated in the core of the juvenile Reindeer zone of the Paleoproterozoic Trans-Hudson orogen (THO). It is underlain by dominantly Burntwood group rocks, with subordinate calcalkaline plutons and sheets of anatectic granitoids. The Burntwood group forms a monotonous sequence of graphite-bearing metagreywacke-mudstone, which was metamorphosed to garnet-biotite gneiss and migmatite throughout much of the Kisseynew domain during the terminal collision of the THO. The metagreywacke-mudstone is interpreted as turbidite deposits shed from the surrounding juvenile accretionary-arc complexes of the Flin Flon and Lynn Lake domains (Ansdell et al., 1995; Zwanzig and Bailes, 2010). Coeval fluvial-alluvial deposits on the margins of the Flin Flon and Lynn Lake domains make up the Missi and Sickle groups, respectively (Stauffer, 1990; Zwanzig and Bailes, 2010). The Kisseynew paleobasin is generally interpreted as a back-arc basin; however, an inter-arc or fore-arc basin environment is also possible (Ansdell et al., 1995; Zwanzig, 1997; Corrigan et al., 2009; Zwanzig and Bailes, 2010).

Sub-Phanerozoic Kisseynew domain

The sub-Phanerozoic Kisseynew domain is the southern extension of the Kisseynew domain below the Phanerozoic cover (Figure GS2020-3-1). Situated between the Superior craton margin

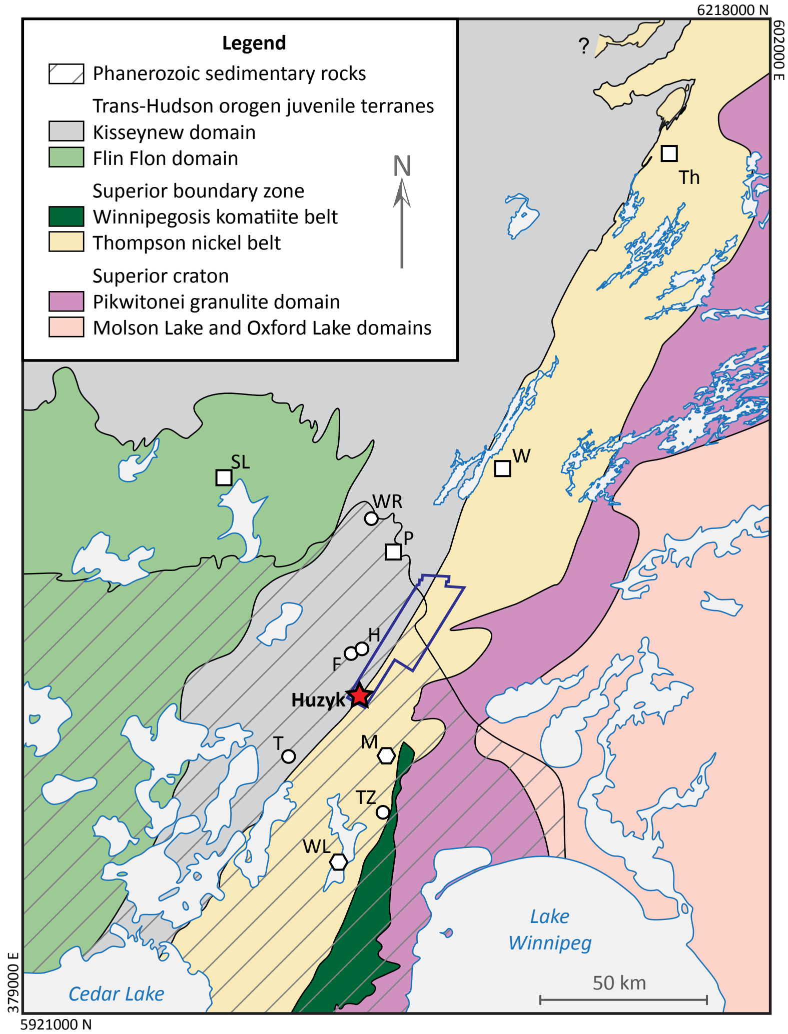

Figure GS2020-3-1: *Geological domains along the Superior boundary zone, central Manitoba (Couëslan, 2020). The dark blue outline is the approximate location of the Huzyk Creek property of Vanadian Energy Corp. Symbols: circles, Cu-Zn deposits in the sub-Phanerozoic Kisseynew domain and Superior boundary zone; hexagons, Ni-Cu deposits/occurrences in the sub-Phanerozoic Thompson nickel belt; squares, town/city/locality; star, location of the 2019 diamond-drilling campaign at the Huzyk Creek property. Abbreviations: F, Fenton deposit; H, Harmin deposit; M, Minago deposit; P, Ponton; SL, Snow Lake; T, Talbot deposit; Th, Thompson; TZ, Tower zone deposit; W, Wabowden; WL, William Lake occurrence; WR, Watts River deposit. Co-ordinates are in UTM Zone 14, NAD83.*

and the Flin Flon domain, it was interpreted to consist of migmatitic metasedimentary rocks of the Burntwood group interlayered with felsic metaplutonic veins and sheets (Leclair et al., 1997). However, the discovery of several volcanogenic massive sulphide (VMS) deposits (Watts River, Harmin, Fenton and Talbot) in the domain has brought this interpretation into question (Simard et al., 2010). Recent studies (Simard et al., 2010; Bailes, 2015; Reid, 2018) suggest complex structural interleaving of Flin Flon domain arc rocks, Kisseynew domain Burntwood group rocks and possibly Thompson nickel belt rocks within the sub-Phanerozoic Kisseynew domain. A similar situation occurs along the north, south and east flanks of the exposed Kisseynew domain, where thrusts and recumbent folding have structurally interleaved rocks of the Kisseynew basin with rocks of adjacent juvenile volcano-plutonic terranes and evolved Archean crust (Zwanzig, 1999; Rayner and Percival, 2007; Zwanzig and Bailes, 2010).

Geology of the Huzyk Creek drillcore

The core from two drillholes (HZ-19-1 and HZ-19-2) was logged in August of 2019 to investigate V-enriched graphite mineralization on the property. The Huzyk Creek drillcore consists of a hornblende gneiss and calcsilicate package in contact, and locally interleaved, with a wacke-mudstone suite containing the V-enriched graphite mineralization (Figure GS2020-3-2). The hornblende gneiss and calcsilicate rock occur at the top of the Precambrian in both drillholes; however, the stratigraphic younging direction is not known. The gneiss and calcsilicate can be interlayered on scales ranging from <1 cm to 2.5 m, with diffuse contacts (Figure GS2020-3-3a). They are interpreted as variably altered mafic rocks, possibly basalt, and may be related to Missi-age, successor-arc magmatism (Couëslan, 2020). In drillhole HZ-19-1, the hornblende gneiss and calcsilicate are interleaved with the underlying wacke-mudstone at

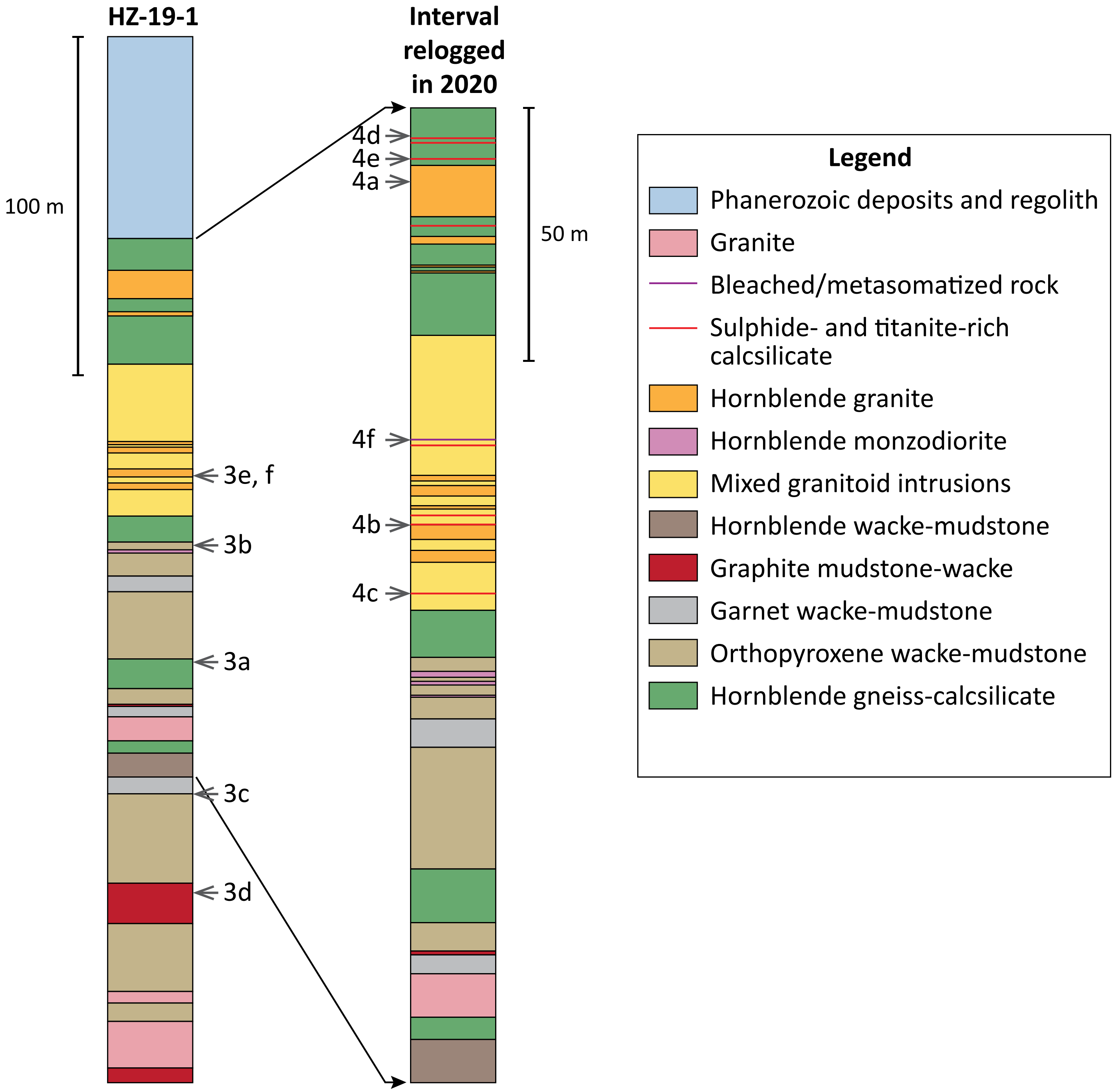

Figure GS2020-3-2: *Schematic logs of drillcore HZ-19-1 from the Huzyk Creek property, including a more detailed section of the interval that was revisited in 2020. Thicknesses of sulphide- and titanite-rich calcsilicate, and bleached/metasomatized rock are not to scale. The stratigraphic positions of images in Figures 3 and 4 are indicated along the inside edge of each column.*

a scale of 2.6–35 m. A preserved contact between calcsilicate and the wacke is sharp with no significant change in strain across the contact (Figure GS2020-3-3b). This may suggest a contact that is stratigraphic rather than tectonic (faulted). The wacke-mudstone package consists of migmatitic gneisses that are subdivided according to the dominant mafic mineral other than biotite. They consist of orthopyroxene wacke-mudstone with subordinate garnet wacke-mudstone (Figure GS2020-3-3c) and graphite mudstone (Figure GS2020-3-3d), and rare hornblende wacke-mudstone. The various wacke-mudstone units are interlayered at a scale of <1 cm to several metres, with the exception of the graphite mudstone that occurs as a discrete horizon roughly 15 m thick. The wacke-mudstone package appears to be related to the Burntwood group of the Kisseynew domain and was likely deposited relatively proximal to the Flin Flon arc-collage (Couëslan, 2020).

The gneisses outlined above were intruded by several types of felsic rocks ranging from tonalite to granite. The intrusions range in size from several centimetres up to roughly 20 m. All intrusions have a well-defined foliation except for a coarse-

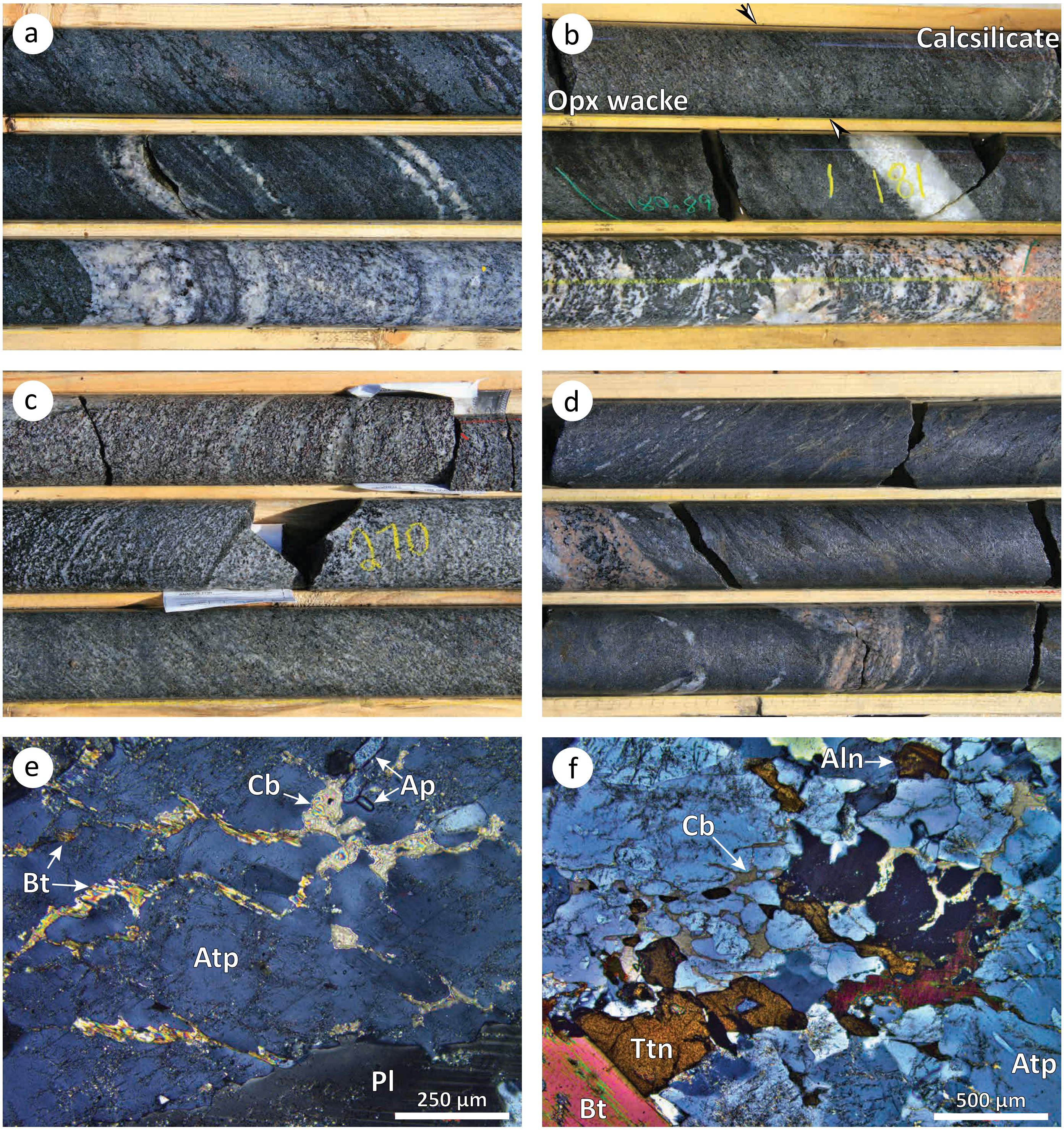

Figure GS2020-3-3: *Drillcore and thin-section images of rocks from drillhole HZ-19-1:* ***a)*** *diffusely interlayered calcsilicate and hornblende gneiss (top two rows; 221.65 m);* ***b)*** *contact between orthopyroxene wacke and calcsilicate (top row, marked with arrows), interlayered calcsilicate and hornblende gneiss (middle row), and quartz monzodiorite (bottom row; 179.4 m);* ***c)*** *interbedded garnet wacke (top row) and orthopyroxene wacke (bottom row; 268.5 m);* ***d)*** *graphite mudstone (HZ-19-1, 303.2 m);* ***e)*** *photomicrograph in cross-polarized light of hornblende granite (sample 108-19-HZ22) with carbonate and biotite microveinlets crosscutting antiperthitic plagioclase; and* ***f)*** *photomicrograph in cross-polarized light of carbonate microveinlets with associated titanite and allanite. Abbreviations: Aln, allanite; Ap, apatite; Atp, antiperthite; Bt, biotite; Cb, carbonate; Opx, orthopyroxene, Pl, plagioclase; Ttn, titanite.*

grained hornblende granite that is locally weakly foliated, and a medium-grained biotite granite that is weakly foliated to massive. A thin section of the hornblende granite revealed microveinlets of carbonate and biotite (Figure GS2020-3-3e), the partial replacement of plagioclase and hornblende by biotite and carbonate, and a close association of titanite and allanite with the biotite and carbonate (Figure GS2020-3-3f). Relatively coarse antiperthite is common, along with zones of myrmekite. The veinlets, replacement textures and feldspar-exsolution textures suggest the granite was metasomatically overprinted. The metasomatized granite was found to be enriched in Ba (14 300 ppm), Sr (3717 ppm), Zr (1304 ppm) and LREE (1303 ppm), and is geochemically similar to metasomatic rocks associated with syenite complexes elsewhere in the Reindeer zone of Manitoba (e.g., the Burntwood, Brezden and Eden Lake intrusive complexes; Martins, 2016a–c; Couëslan, 2020).

Relogging results

Approximately 190 m (from 71.5 to 262.9 m) of drillcore HZ-19-1 was relogged and sampled in July 2020 (Figure GS2020-3-2). The focus of this study was to document the hornblende granite and possible evidence of related metasomatic overprint in the core. Although definitive examples of metasomatism are rare, two phases of potential interest were recognized in the core: sulphide- and titanite-rich calcsilicate, and a bleached rock. These phases, along with the hornblende granite, appear to be restricted to the upper 116 m of the Precambrian (from 71.5 to 187.3 m). The significance of these phases remains uncertain pending geochemical and petrographic analyses. In addition, samples of other granitoid rocks were collected for geochemical comparison with the hornblende granite. Reported thicknesses in this report are intersection lengths, not true thicknesses.

Hornblende granite

The hornblende granite occurs from the top of the Precambrian (71.5 m) to 160.6 m as dikes up to 10 m but typically <3 m. The granite is pink to grey, coarse grained and weakly foliated (Figure GS2020-3-4a, b). Biotite, hornblende and clinopyroxene, combined, typically make up less than 10% of the rock, along with minor titanite and sulphide; however, the granite can locally contain up to 5% pyrrhotite, 7% titanite and 20% hornblende and clinopyroxene. Biotite locally occurs as rims on hornblende grains. The hornblende granite is petrographically similar to some intrusive phases associated with the Burntwood, Brezden and Eden Lake intrusive complexes of the THO of Manitoba (Couëslan, 2005; Martins, 2016a–c). A sample of the hornblende granite collected in 2019 displayed evidence of metasomatism in thin section and was found to be geochemically similar to metasomatized rocks from the intrusive complexes listed above, including elevated Ba, Sr and La/Yb. However, no obvious evidence for metasomatism is visible in the drillcore, and slight geochemical differences (including enrichment in Zr) may be more suggestive of an A-type granite affinity (Chakhmouradian, pers. comm., 2020).

A second variety of hornblende-bearing granitoid occurs from 182.0 to 187.3 m as dikes <1.2 m thick. The dikes are pale pink to greenish white, coarse grained and foliated (Figure GS2020-3-3b). They are mineralogically similar to the hornblende granite but are relatively poor in quartz (quartz monzonite/quartz monzodiorite?) and contain trace amounts of ilmenite rather than titanite. It is uncertain if the two varieties of hornblende-bearing granitoids are related.

The close association between the hornblende granite and the hornblende gneiss and calcsilicate suggests that the granite could represent a granitoid phase that was contaminated by the country rock via partial digestion or xenocryst entrainment. However, this would not explain the enrichment in Ba, Sr, Zr and LREE reported from the single geochemical analysis in 2019 (Couëslan, 2020). Three additional samples of titanite-bearing hornblende granite and one sample of the ilmenite-bearing quartz monzodiorite were collected for further study.

Sulphide- and titanite-rich calcsilicate

Calcsilicate is common from the top of the Precambrian to 254.5 m, where it is diffusely interlayered with hornblende gneiss and is interpreted to represent carbonate and/or epidote alteration within mafic igneous rocks (possibly basalt; Couëslan, 2020). The calcsilicate is plagioclase rich, with 30–40% clinopyroxene, and contains trace amounts of carbonate, magnetite, pyrrhotite, titanite and local garnet (Figure GS2020-3-3a). Several examples of anomalously sulphide-rich (up to 15%) and titanite-rich (up to 7%) calcsilicate were identified in the drillcore. Varieties can be similar to the typical calcsilicate described above, but with up to 3% magnetite, 3% sulphide and 7% titanite (Figure GS2020-3-4b), or they can be enriched in epidote, titanite and sulphide with minor carbonate (Figure GS2020-3-4c). Locally, the enriched calcsilicate appears to overprint the fabric of the country rock (Figure GS2020-3-4d); however, it also occurs as xenoliths with a well-developed fabric hosted within the hornblende granite (Figure GS2020-3-4b). There are also rare examples of discordant vein-like calcsilicate (Figure GS2020-3-4e). The wide textural and mineralogical variability likely indicates multiple ages and origins for the sulphide- and titanite-rich calcsilicate. Four samples of sulphide- and titanite-rich calcsilicate were collected for thin-section and geochemical analysis.

Bleached rock

A single zone of bleached rock, approximately 40 cm thick, occurs within the multicomponent gneiss interval. It is light grey and moderately magnetic with sharp contacts that crosscut fabrics and structures (including xenoliths) in the host tonalite (Figure GS2020-3-4f). The rock consists dominantly

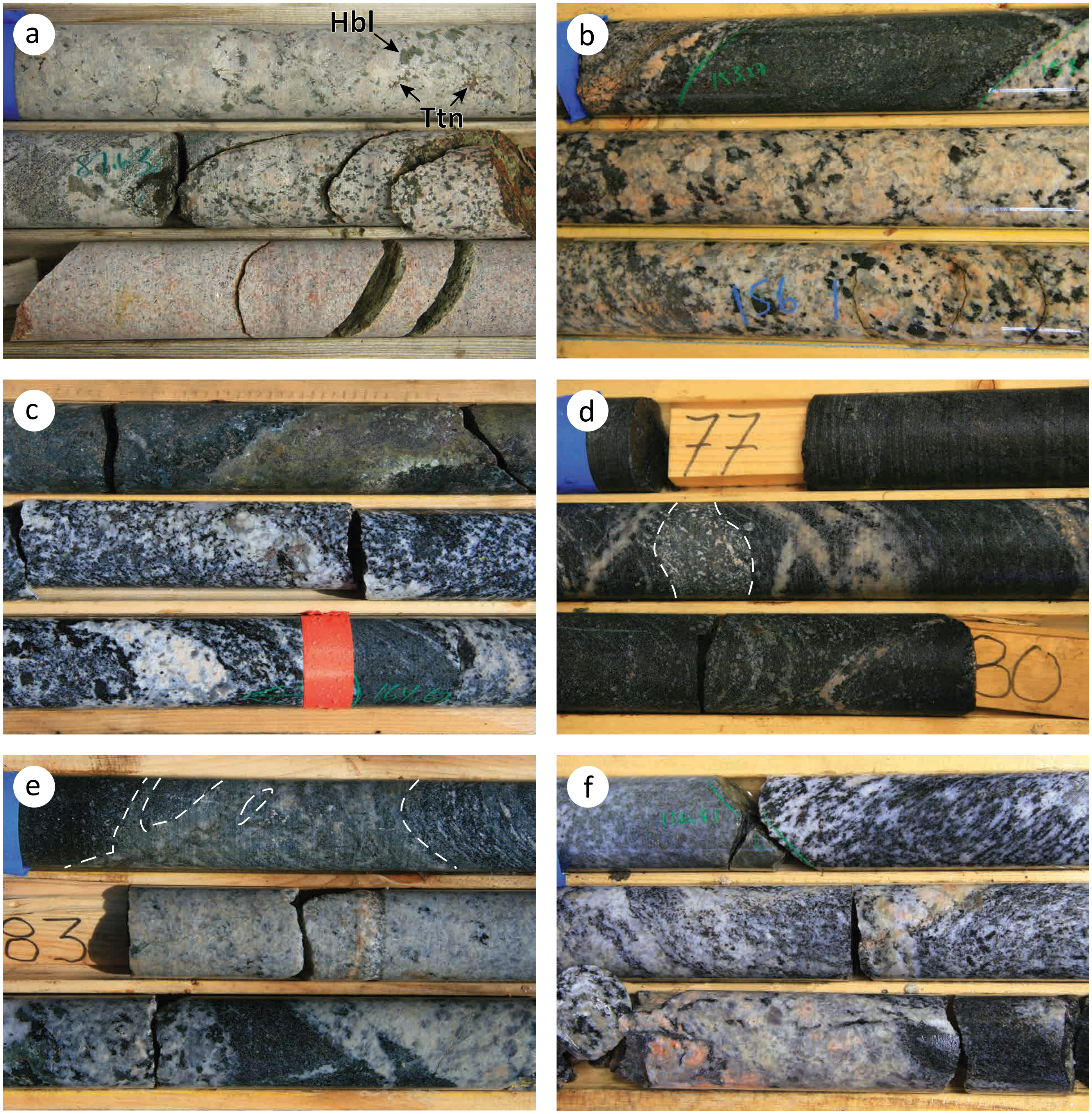

***Figure GS2020-3-4:** Drillcore images of rocks from drillhole HZ-19-1: **a)** hornblende granite (top two rows) and aplite (bottom row; 86.0 m); **b)** xenolith of foliated sulphide- and titanite-rich calcsilicate (top row) contained within hornblende granite (bottom two rows; 153.1 m); **c)** titanite-, sulphide- and epidote-rich calcsilicate (top row; 167.7 m); **d)** titanite-rich calcsilicate that overprinted the fabric of the country rock (middle row, dashed outline; 77.0 m); **e)** discordant, vein-like calcsilicate in hornblende gneiss (top row, dashed outline), the hornblende gneiss intruded by hornblende granite (bottom two rows; 81.6 m); **f)** bleached/metasomatized rock that overprinted tonalite (top row, left of green line; 136.7 m). Abbreviations: Hbl, hornblende; Ttn, titanite.*

of quartz and feldspar with 10–12% pale green amphibole and minor carbonate, titanite and sulphide. A sample of the bleached rock was collected for thin-section and geochemical analysis.

Economic considerations

Alkaline-affinity magmatism and A-type granites can both be associated with rare-metal mineralization. Zirconium, Nb, Y, REE and F mineralization can be found associated with A-type granites (Dall'Agnol and Rämö, 2009). Alkaline-affinity igneous complexes in the THO of Manitoba have been explored for U, REE and P, and the Eden Lake complex is host to postorogenic carbonatite intrusions (Chakhmouradian et al., 2008). Post-orogenic carbonatites are a major source for the global supply of REE (e.g., Hou et al., 2009). Most of these elements are considered critical materials/minerals by the U.S. Department of the Interior (Schulz et al., 2017). Further work is required to determine the affinity of the hornblende granite and the significance of the sulphide- and titanite-rich calcsilicate and bleached rock. If the hornblende granite is related to either A-type granite magmatism or alkaline-affinity magmatism, it could indicate potential for these deposit types in the area, especially if a larger igneous complex or dike swarm is found to be present.

Acknowledgments

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