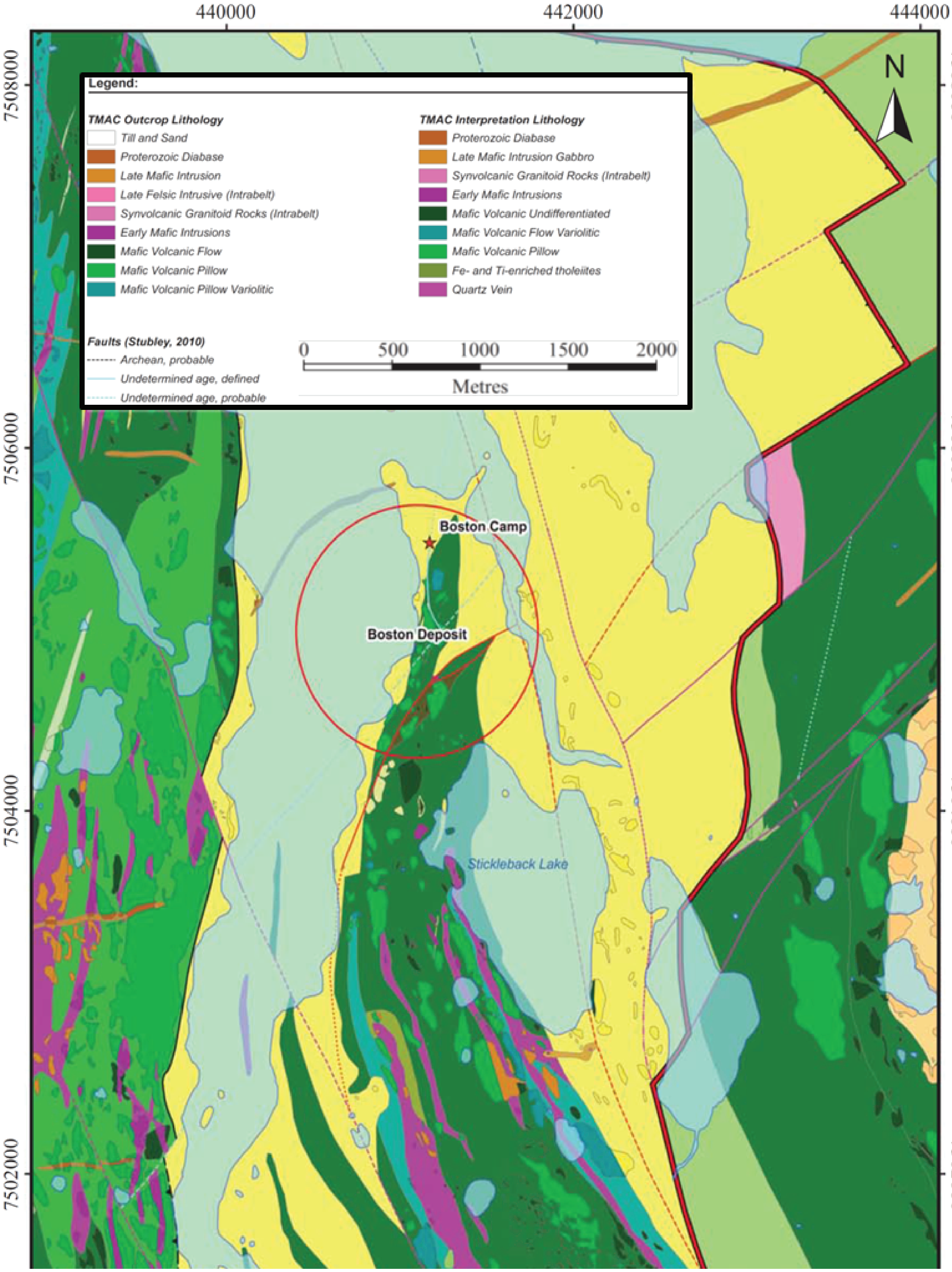
Figure 4.2-4

Detailed Geology Map of the Boston Area



4.2.4.1 Lithologies

The mafic volcanic rocks recognized in the Boston area include the Boston suite and the East and West Spyder suites. These are characterised by pillow lavas that typically contain small, amygdaloidal, highly deformed pillow shapes that are unreliable way-up criteria and facing orientation is provided by pillow shelves. Interflow sediments are relatively common and comprise argillite with lesser chert. Variolitic and non-variolitic mafic volcanic rocks form consistent map units with non-variolitic units most abundant, underlying much of the map area. Although poorly exposed, a distinct variolitic phase is recognized in the Boston suite which can be correlated over several kilometres, containing large varioles, developed around pillow selvages and as coalesced varioles within pillows. Varioles may be highly elongate, defining a strong stretching lineation. The sedimentary succession, where exposed on the lakeshores ranges from quartzo-feldspathic wackes to a fine-grained argillite and are well-graded, providing facing directions.

4.2.4.2 Structural Geology

A large south-plunging, north-facing anticlinal fold dominates the geology of the Boston area. The core of the anticline is occupied by mafic volcanic rocks, that host the Boston deposit, and these are in turn overlain by sedimentary strata. The structure is defined by facing directions, recognized by graded bedding, bedding-cleavage relationships and from pillow shelves in the mafic volcanic rocks. The fold geometry is that of an elongate ellipsoid of mafic volcanic rocks surrounded by sedimentary rocks. The ellipsoidal shape is the result of either refolding or by development of a sheath fold (Stubley 2005).

The Fault architecture is shown in Figure 4.2-5. The fault system comprises a set of thrust faults that are offset by younger NE trending to ENE-trending faults. Newmont named four Faults, the Cambridge, Somerville, Brookline and Chelsea Faults within the proposed pit area, adjacent to the existing underground development (Figure 4.2-5). Drill core investigation by SRK (2008) showed that the faults typically contain a brecciated graphitic fault zone up to 1.5 m thick with a variable amount of soft gouge, between 2 and 15 cm. Fault damage zones were reported up to 7 m in thickness (SRK 2008).

4.2.4.3 Mineralisation

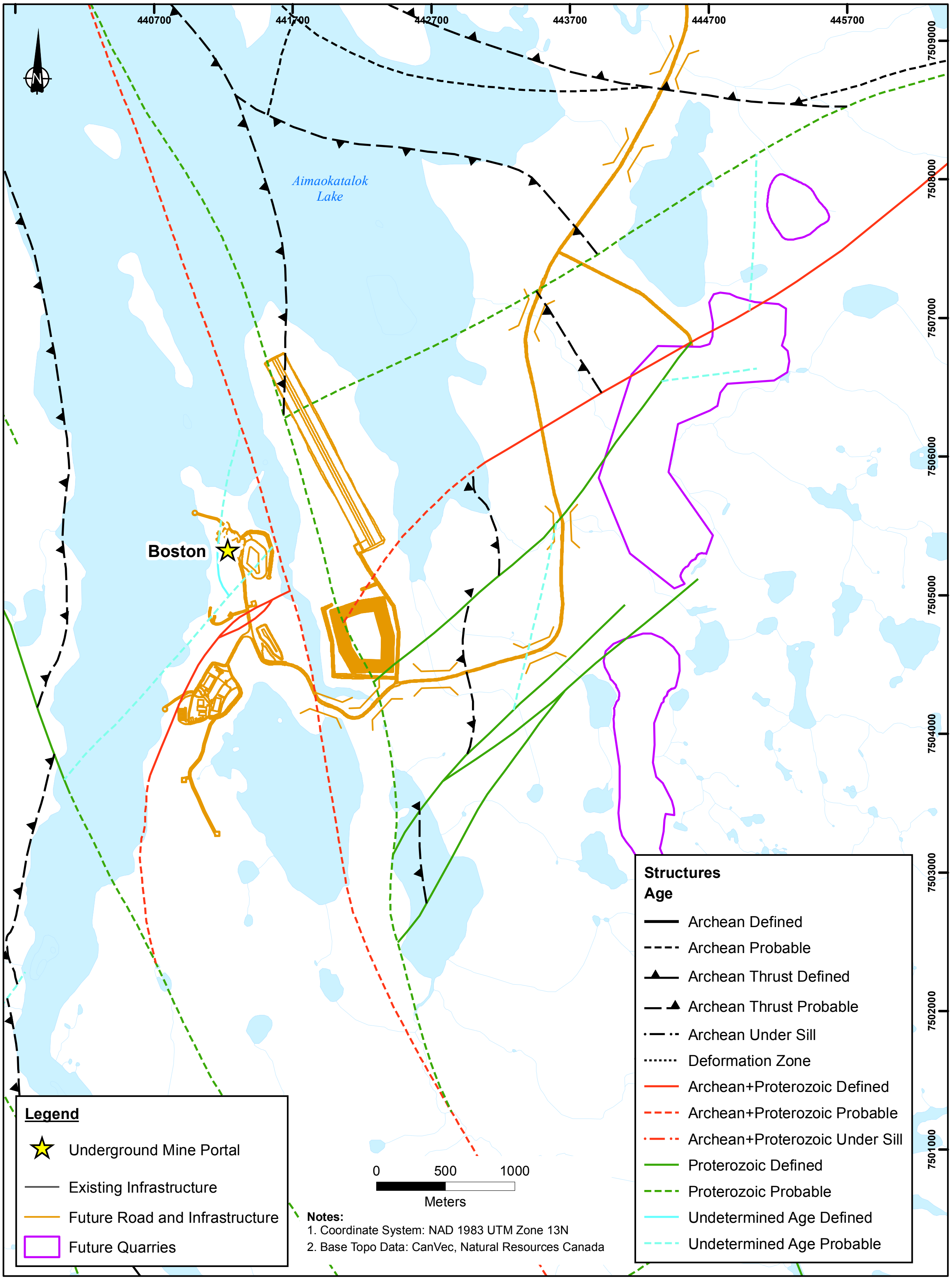
Gold mineralization is associated with a complex anastomosing high strain zone that has an orientation approximately axial planar to the main anticline, interpreted as a late D_2 structure (Sherlock et al. 2012). Auriferous veins are developed on the western side of the fold at the contact between the mafic and overlying sedimentary succession (Figure 4.2-6) and form a series of anastomosing fault fill veins on the western limb of the fold and at the contact with the overlying sedimentary rocks (Clarke 1996). Mineralisation is associated with proximal ankerite, quartz and sericite, with a distal assemblage of chlorite and calcite (Sherlock and Sandeman 2004; Stemler et al. 2006).

4.2.4.4 Surficial Deposits

The Boston area has a low to moderate relief, of no more than 50 m. Surficial deposits that overly the bedrock, comprise: glacial tills, marine sediments, glaciofluvial deposits, lacustrine deposits and alluvial deposits (EBA 1996). Till is widespread, but mostly confined to elevations above 80 m elevation, where it is exposed on the flanks of bedrock outcrops as relatively thin, approximately 1 m thick infill and depressions in the bedrock, with a maximum thickness of 7 m recorded (EBA 1996). Till typically has a sand matrix with variable amounts of silt, gravel, cobbles and boulders. Till is overlain by marine deposits, approximately 5 m thick, which typically consist of silt and clay with traces of sand and shells present. In the southwestern portion of the area, marine deposits form two well defined terraces.

Figure 4.2-5

Detail of Major Structures and Relationship to Boston Area Infrastructure

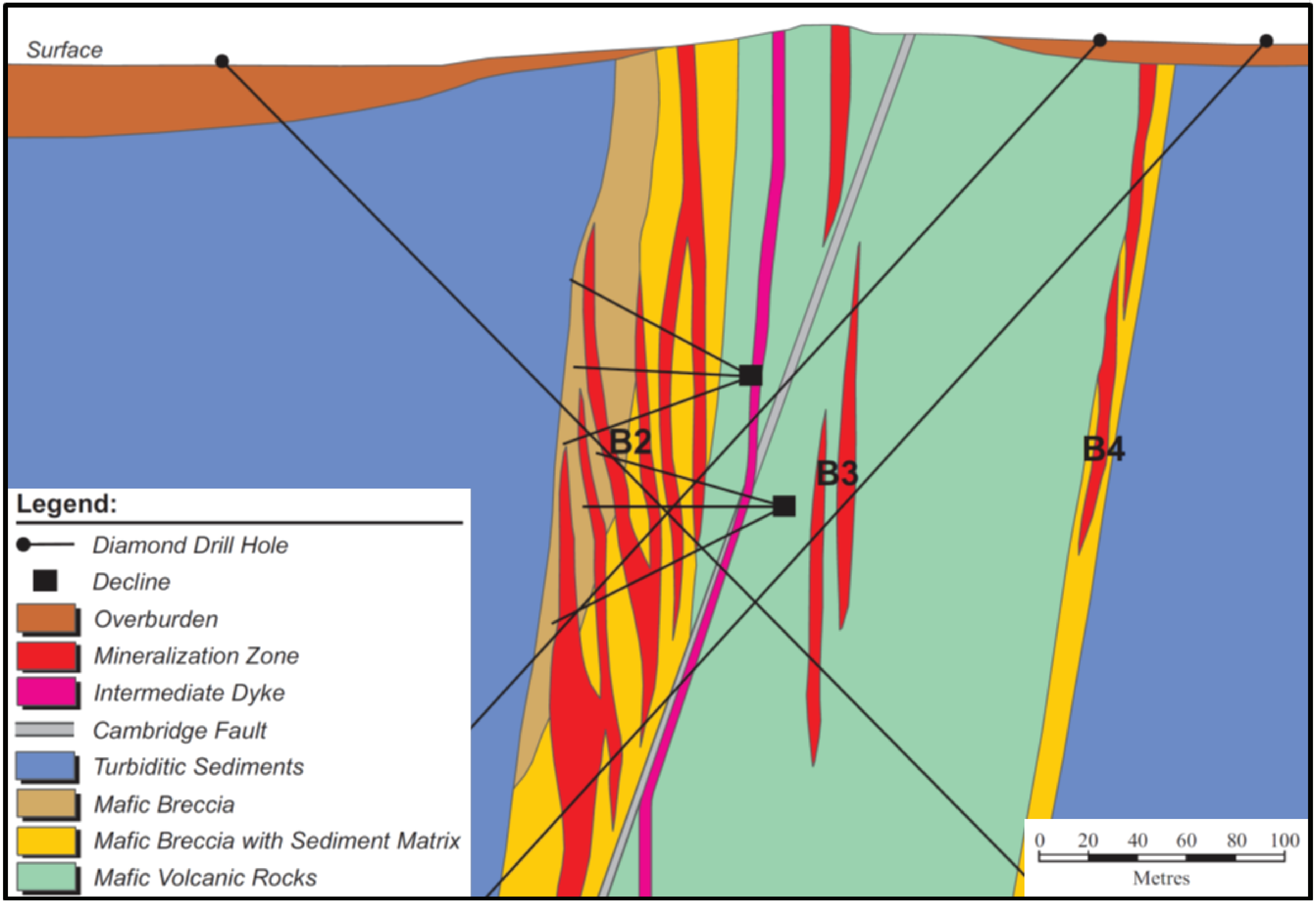


\\VAN-SVR0\Projects\01_SITES\Hope.Bay\!ACAD\2016 Drawings\1CT022.004.200.10_StructuresBoston_mzs.mxd

Source: SRK, 2016.

Figure 4.2-6

Schematic Cross-section of the West-East Section of the Boston Mineralisation



Marine deposits are overlain by glaciofluvial deposits developed as eskers and isolated patches of sand and gravel (EBA 1996). Sediment comprises mainly coarse sand with gravel, boulder and cobble lags. Eskers are typically 3 m high and between 10 and 12 m in width. Lacustrine deposits were exposed as lakes shrank and underlie plains and gentle slopes adjacent to lakes. Deposits typically comprise silt and sand with a few lenses of organic detritus. Two ages are recognised, a more recent (Holocene) and a Holocene-Pliocene age. Alluvial deposits are found within floodplains and low river terraces and consist of sand and gravel that may contain lenses of organic material (EBA 1996).

4.2.5 Doris Area

The Doris deposit is situated at the northern Hope Bay greenstone belt (Figure 4.2-7). Mineralisation occurs within a steeply dipping, over 3 km-long quartz vein system in folded and metamorphosed pillow basalts. At the north end, the veins are folded forming a high-grade anticlinal hinge zone lying close to surface (the Doris Hinge; Figure 4.2-8). The anticlinal fold axis extends south through Doris Lake, marking the transition between east-facing strata on the east shore of Doris Lake and west-facing strata on the west shore of Doris Lake

4.2.5.1 Lithologies

Several distinct suites of mafic volcanic rocks are recognized in the Doris area and are broadly divisible into Mg and Fe tholeiites. Although this is based on the existing lithogeochemical database, the chemically distinct units a field and visual descriptor for each unit has been developed. The Fe tholeiites can contain elevated TiO_2 values and all rock units can be further subdivided based on the presence or absence of varioles, amygdales and magnetism (Carpenter et al. 2003).

4.2.5.2 Structural Geology

The dominant structure in the area is a tight to isoclinal antiform structure (Figure 4.2-7). The fold axis strikes approximately north-south and is doubly plunging. The antiform plunges shallowly to the north around the Doris deposit, and shallowly to the south at the south end of Doris Lake. The antiform axial plane is slightly inclined with an east vergence. The antiform is mapped based on younging directions from gas cavities in the pillowed Mg tholeiitic basalts.

Late brittle faults typically are less than one metre in width and be traced for over one kilometre (Figure 4.2-8). In several cases, stratigraphic offsets up to 5 m are recognized across these structures with a consistent apparent sinistral displacement. These structures offset the mineralization and three distinct faults are mapped and inferred in drill core; the Lakeshore Fault, the Glacier Fault and the Valley Fault. Interpreted displacements for all of these faults include left-lateral and north-side down movement. These faults do not cross-cut or offset the Franklin diabase. Faults are typically marked by rubble zones associated with sericitic alteration, slickensides, brecciation and clay gouge. Graphitic alteration, common at Madrid and Boston, has not been observed at Doris (SRK 2008).

4.2.5.3 Mineralisation

Gold mineralization at Doris is hosted in a conformable succession of mafic volcanic and gabbroic rocks that are folded into a tight, shallowly north-plunging antiform. Mineralisation is associated with continuous quartz veins with sericite and tourmaline-rich septa with Fe dolomite, sericite, paragonite, and pyrite alteration. Three significant, north-trending vein systems are known: West Valley Wall, Central, and Lakeshore veins (Figure 4.2-9). The Hinge zone occurs where the Central and Lakeshore veins merge. The overall geometry of the vein systems closely mimics the regional antiformal fold geometry in basaltic and gabbroic rocks. Textural relationships and vein geometries are consistent with vein precipitation along bedding-parallel fault zones during folding, developing a saddle-reef geometry during D_2 strain (Hodgson 1989, Carpenter et al. 2003).

Figure 4.2-7

Bedrock Geology of the Doris Deposit on the Western Shore of Doris Lake

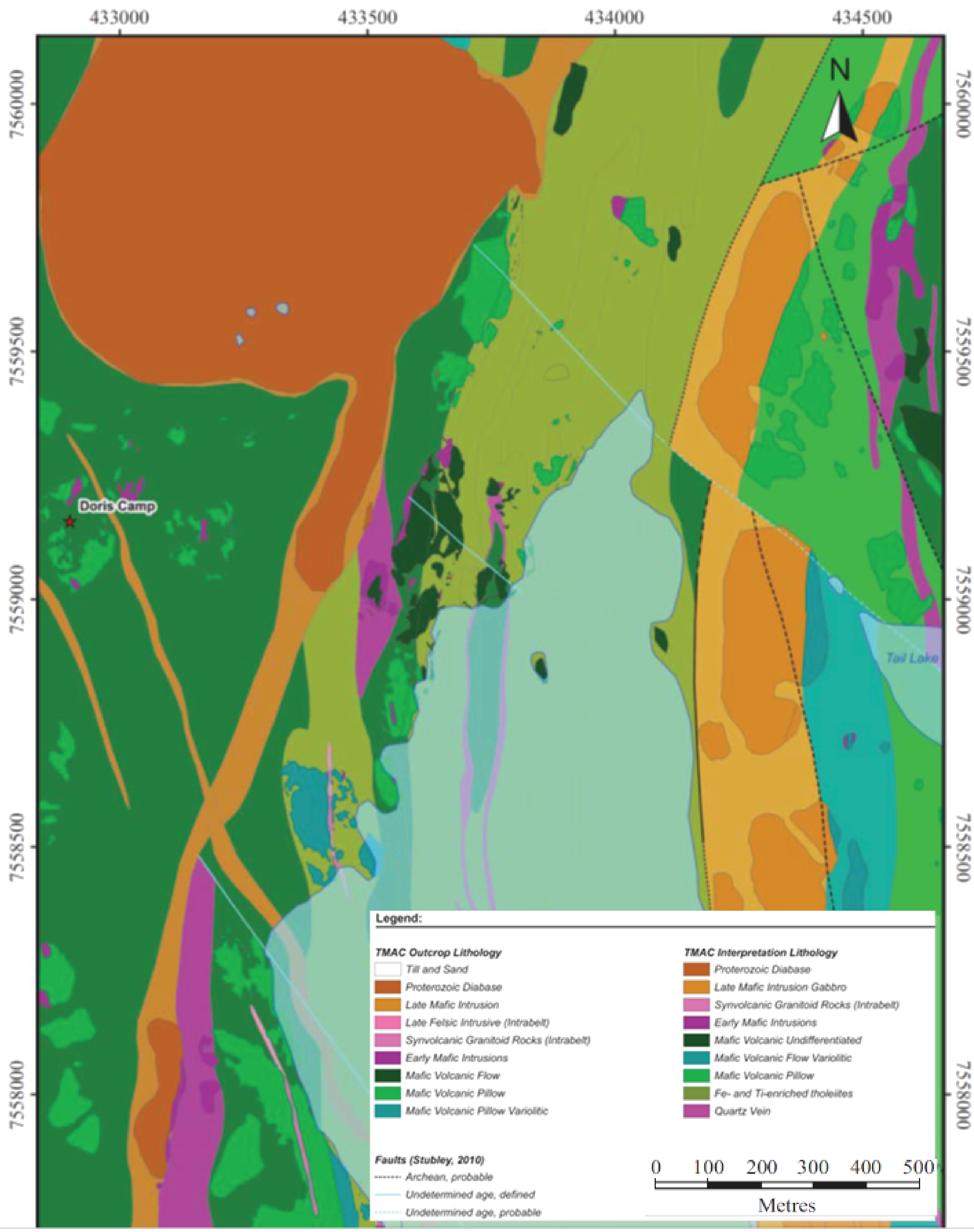
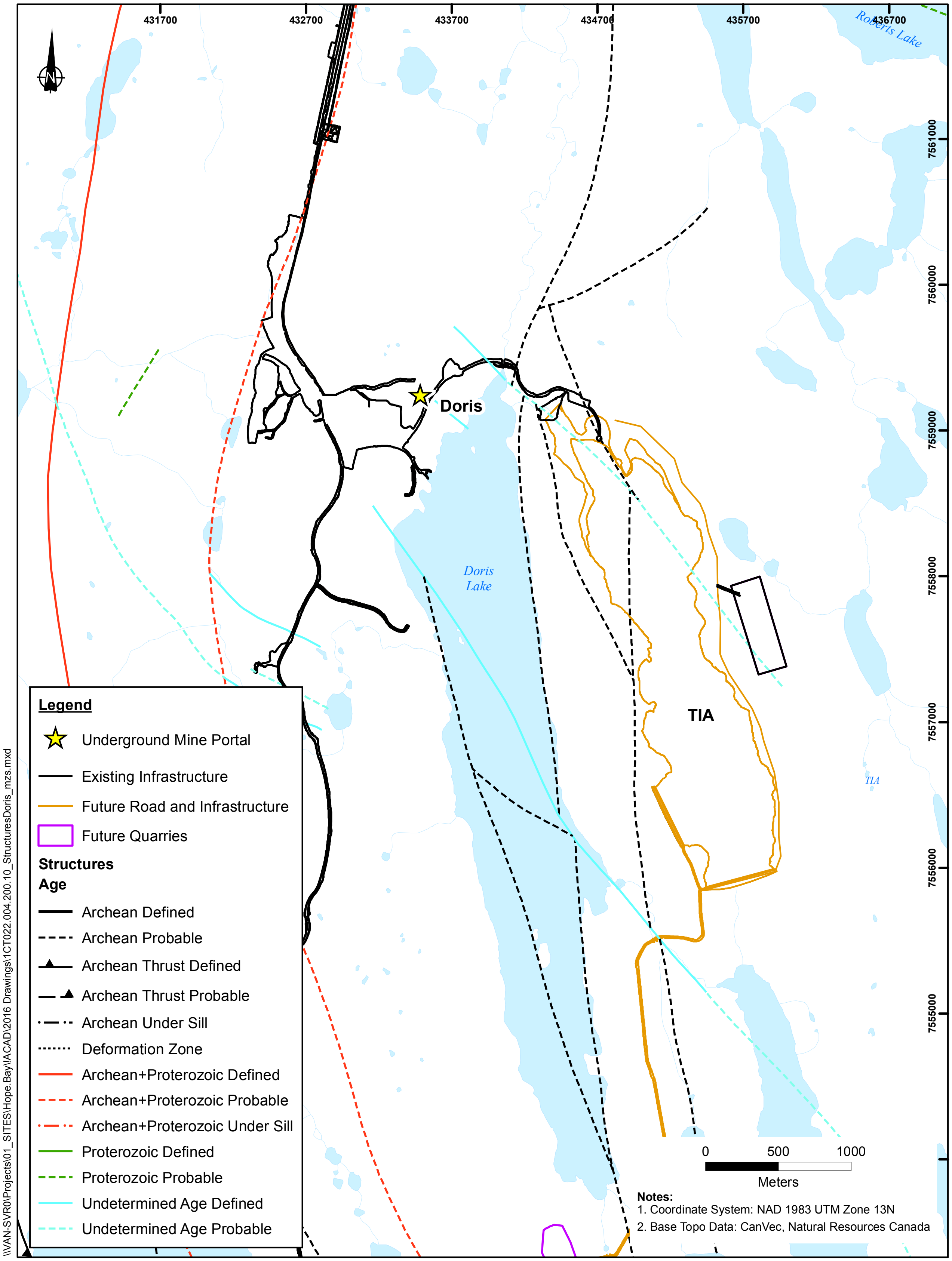


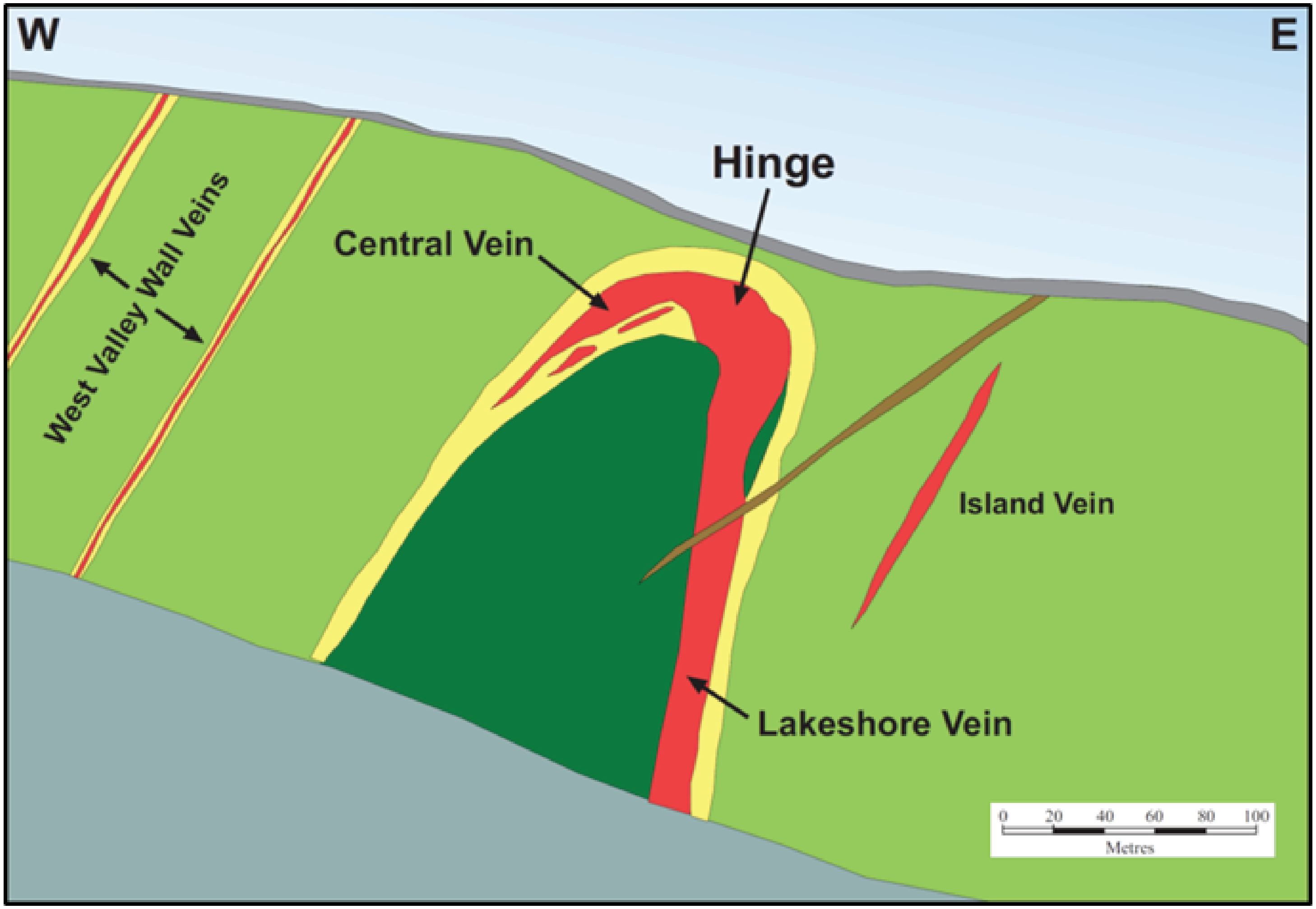
Figure 4.2-8
Regional Faults in the Doris Area



Source: SRK, 2016.

Figure 4.2-9

Schematic West East Section of the Doris Deposit Showing the Folded Mineralisation in the Doris Hinge



4.2.5.4 Surficial Deposits

Surficial deposits at in the Doris area consist mainly of marine clay, silts and some sand (Kerr and Knight 2001; Thurber Engineering 2008) with thickness up to 20 m reported from between Roberts Bay and Tail Lake. Surficial geology is consistent with the Hope Bay region, although no Quaternary Late Wisconsin, glacial deposits were found exposed in the area (Thurber 2003). These are considered either buried by post-glacial marine deposits or have been reworked during the marine regression. Marine sediments comprise clay, silt, sand and gravel, with relatively common marine shells. Three subdivisions are recognised: marine veneer sediments (M1), marine blanket sediments (M2) and Littoral deposits (M3). M1 sediments are no more than 2.5 m thick and comprise clay to sand matrix with pebble, cobbles and boulders that fill depressions within the bedrock. M2 deposits comprise clay, silt and sand up to 20 m in thickness, generally with a coarsening upward sequence (Kerr and Knight 2001). These deposits are overlain by M3 littoral deposits that comprise sand, gravel, cobbles ad boulders deposited in emergent spit and beach deposits during the marine regression. These are typically less than 2 m thick and overlie either bedrock or the finer grained marine blanket (Thurber 2003).

4.2.6 Madrid Area

The Madrid deposit area is located in the north-central part of the belt, south of the Doris deposit (Figure 4.2-2). It includes the Wolverine-Madrid corridor which is defined as the belt of rocks extending from the southern end of Wolverine Lake to the northwest end of Patch Lake (Sherlock et al. 2002). The Madrid deposit area comprises the Naartok East, Naartok West, Rand, Suluk, Wolverine and Patch 14 deposits, while the Madrid trend includes the Spur, Suluk T3, South Suluk, and Patch 7 prospects.

4.2.6.1 Lithologies

The rocks within the Madrid corridor consist primarily of north-south striking mafic volcanic rocks (Figure 4.2-10). These include a sequence of iron-titanium tholeiitic basalts, magnesium- tholeiitic basalts, komatiitic basaltics, synvolcanic to late gabbroic and ultramafic rocks (RPA 2015). Several intervals of felsic rocks are present in the immediate Wolverine area. These include felsic fragmental rocks and massive quartz-feldspar-phyric bodies. The fragmental rocks are distinguished by their clastic nature with numerous chloritic fragments, and coarse grained feldspar and quartz phenocrysts. Massive quartz-feldspar-phyric bodies are considered to represent small sub-volcanic intrusions or flows with the main felsic intrusive phase centred under Wolverine Lake.

Rocks of the northern Madrid area, Naartok West to Suluk, are classified based on textural and lithogeochemical similarities. The general stratigraphy of the area is composed of three major volcanic packages: Wolverine Group (C-type rocks), Patch Group (A-type rocks), and a C-type tholeiite (PGP) (Watts, Griffis and McQuat Limited 2006). The Naartok stratigraphy consists of a package of intercalated C-type and A-type basalts with interflow sediment, dipping to the north at Naartok West, and moderately westerly dipping in Naartok East. At Rand, stratigraphy consists of a steep northerly dipping package of C-type and A-type variolitic basalts and volcanics. Stratigraphy continues south to Suluk as south-southeast trending, steeply dipping, and west younging volcanic and interflow sediment packages (Watts, Griffis and McQuat Limited 2006).