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STRUCTURAL CONTROLS ON THE NATURE AND DISTRIBUTION OF GOLD IN POLYTECTONIZED PRECAMBRIAN VOLCANO-SEDIMENTARY SUCCESSIONS: AN EXAMPLE FROM THE WHALE TAIL ZONE, AMARUQ PROJECT, NUNAVUT

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1. INTRODUCTION AND GEOLOGICAL SETTING

The Amaruq property is a gold exploration project located approximately 50 km northwest of the Meadowbank Mine, in the Kivalliq region of Nunavut (**Figure 1**). The project, set in northwestern Churchill Province, comprises two main auriferous zones, namely the Whale Tail and IVR zones, along with a series of other gold occurrences, which are all hosted in Neoarchean volcanic and sedimentary rocks of the Woodburn Lake group (Côté-Mantha et al., 2015). These rocks are polydeformed and characterized by upper greenschist facies mineral assemblages (Thompson, 2016).

The Whale Tail zone is predominantly hosted in a steeply dipping metasedimentary succession that strikes E-NE and consists of orthochemical (iron formation and chert) and clastic rocks (greywacke). This host sedimentary succession is flanked to the north by tholeiitic komatiites intercalated with silicate-facies iron formation and to the south by transitional to calc-alkaline ultramafic and mafic volcanic rocks. This supracrustal rock package is bound to the north and south by felsic to intermediate intrusive rocks and cross-cut by lamprophyre dykes.

Two main styles of gold mineralization are present at Whale Tail: (1) stratabound mineralization characterized by the presence of arsenopyrite along with silicification/diffuse quartz veining in chert and by abundant pyrrhotite in iron formation; (2) discordant mineralization characterized by gold-, arsenopyrite ±galena-bearing quartz veins.

The presence of both styles of mineralization at Whale Tail lends itself to a variety of hypotheses with regards to their genesis and relative chronology. The presence of sulfide-rich stratabound mineralization in iron formation-hosted gold deposits is cited by several researchers as evidence supporting syngenetic gold enrichment models (e.g. Kerswill, 1993). This interpretation is however contested by a number of other researchers suggesting that such stratabound mineralization is rather the result of epigenetic hydrothermal replacement of iron formation by iron sulfide assemblages (Bullis et al., 1994; Poulsen et al., 2000; Geusebroek and Duke, 2004).

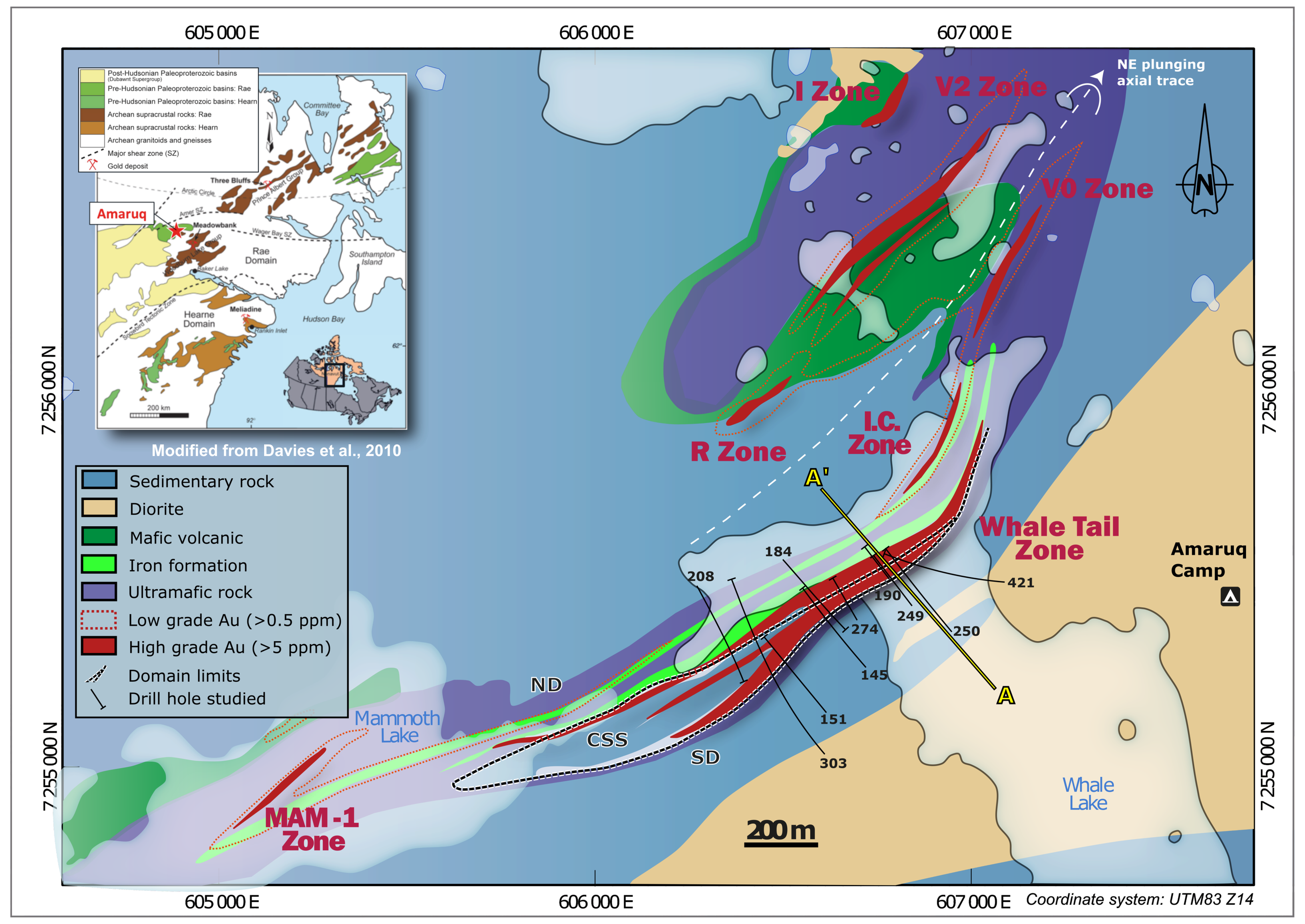

Figure 1. Location and map of the Amaruq project showing the position of the Whale Tail, IVR, I.C. and Mammoth zones, northern domain (ND), central sedimentary sequence (CSS) and southern domain (SD) as well as the diamond drill holes selected in this study.

2. OBJECTIVES AND METHODOLOGY

This study aims to define the nature and relative chronology of structural and lithological elements controlling the geometry and distribution of gold mineralization at Whale Tail.

The study area has a poor outcrop exposure, particularly in the vicinity of the Whale Tail zone, which lies partly under a lake. As a result, most of the data included in this study was gathered from diamond drill core, with only a few observations made on outcrop.

Detailed descriptions of fabrics present in diamond drill core, petrographic analysis of fabrics in thin section and structural analysis were carried out. Diamond drill core from nine bore holes on three sections through the Whale Tail zone was selected for the study as well as oriented drill core from an additional hole transecting the easternmost section (**Figure 1**):

- Section 14850E (**Figure 2**): AMQ15-190, AMQ15-249, AMQ15-250;
- Section 14650E: IVR14-145, AMQ15-184, AMQ15-274;
- Section 14400E: IVR14-151, AMQ15-208, AMQ15-303; and
- Oriented drill core: AMQ15-421.

REFERENCES

Bullis, H.R., Hureau, R.A. and Penner, B.D. (1994). Distribution of gold and sulfides at Lupin, Northwest Territories. Society of Economic Geologists 89 (6).
Côté-Mantha, O., Gosselin, G., Vaillancourt, D., and Blackburn, A. (2015). Amaruq: A new gold discovery in Nunavut, Canada; NewGenGold 2015 meeting, meeting, Extended Abstracts volume, p. 41-56.
Davies, T., Ric171-199.hards, J.P., Creaser, R.A., Heaman, L.M., Chacko, T., Simonetti, A., Williamson, J., and McDonald, D.W. (2010). Paleoproterozoic Age relationships in the Three Bluffs archean iron formation-hosted gold deposit, Committee Bay greenstone belt, Nunavut, Canada. Exploration and Mining Geology, Vol. 19, No. 3-4.
Geusebroek, P.A. and Duke, N.A. (2004). An Update on the Geology of the Lupin Gold Mine, Nunavut, Canada. Society of Economic Geologists 13 (1-4).
Kerswill, J.A. (1993). Models for iron formation-hosted gold deposits, in Kirkham, R.V., Sinclair, W.D., Thorpe, R.I., and Duke, J.M., Mineral Deposit Modelling : Geological Association of Canada Special Paper 40, p.
Poulsen, K.H., Robert, F., and Dubé, B. (2000). Geological classification of Canadian gold deposits. Geological Association of Canada Bulletin 540.
Thompson, P.H. (2016). Applied Metamorphic Petrology Constraints on the Origin and Timing of Gold Mineralization at Amaruq : Phase 2 (Mammoth and IVR). Peter H. Thompson Geological Consulting Ltd.

3. RESULTS AND OBSERVATIONS

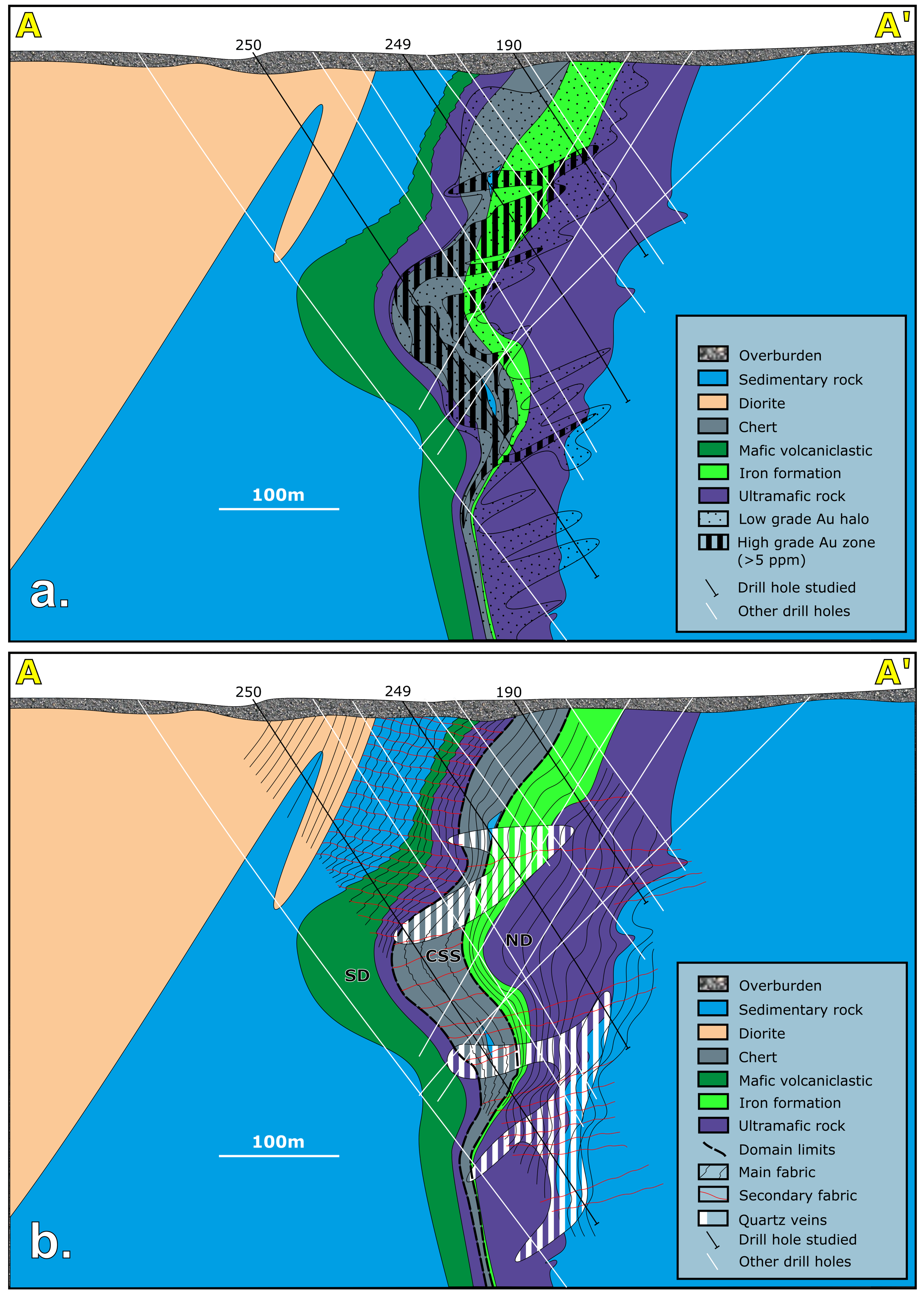

Figure 2. Transversal section 14850E of the Whale Tail zone showing the main lithologies encountered as well as the diamond drill holes studied; a. high grade (>5 ppm Au) shells (striped) and low grade (>0.5 ppm Au) shells (dotted); b. quartz vein shells (striped) and fabric lines interpolated from detailed diamond drill core fabric descriptions.

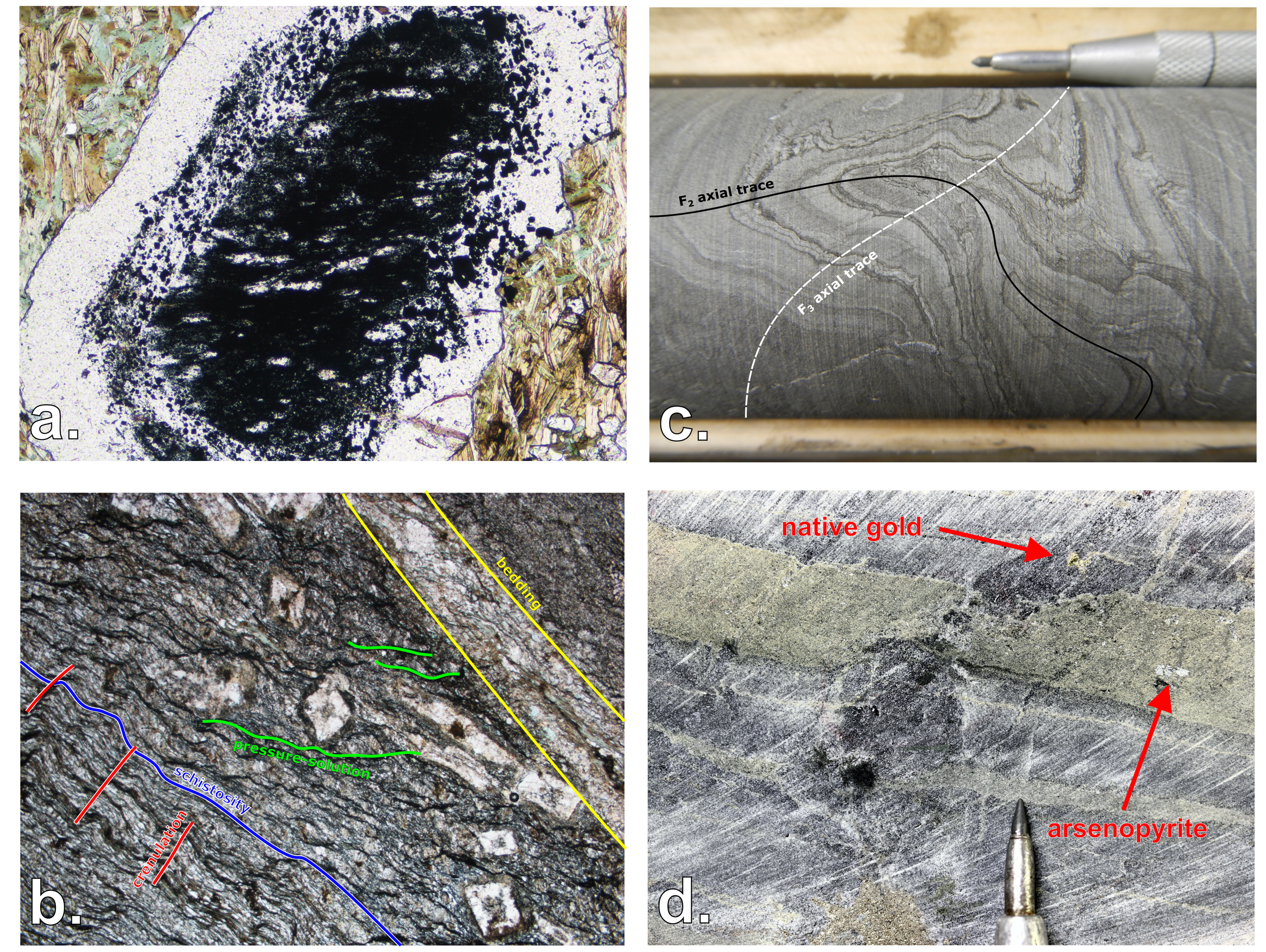

Figure 3. a. Garnet porphyroblast in thin section showing magnetite inclusions in iron formation, seen in plain polarized light. The garnet shows three growth phases; (1) a core characterized by the presence of minute magnetite inclusions recording a pre-metamorphic foliation; (2) a first growth ring characterized by the presence of coarser magnetite inclusions recording a "snowball" syn-kinetic foliation; (3) a second growth ring lacking magnetite inclusions; b. andalusite porphyroblasts in thin section in graphitic argillite, seen in plain polarized light. Bedding is cross-cut obliquely by a pressure-solution cleavage and schistosity, itself cross-cut by a crenulation cleavage; c. mafic volcaniclastite in NQ-diameter (47.6 mm) diamond drill core. Bedding is first tightly folded and then openly refolded; d. silicified chert in NQ-diameter (47.6 mm) half diamond drill core. Native gold in quartz-actinolite vein cross-cutting arsenopyrite-bearing grunerite bands.

Preliminary results, which are insufficient at this time to establish a definitive relative chronology, indicate at least two important fold structures in the study area: (1) a northeasterly plunging asymmetrical fold associated with a strong foliation (main schistosity); and (2) a northwest verging, shallowly plunging overturned fold associated with an axial planar fabric coinciding with the orientation of discordant mineralization corridors (**Figure 2**). Detailed descriptions of fabrics in drill core also suggest a late, locally penetrative axial planar cleavage with no apparent outcome on mineralized zones (**Figure 3c**).

This work aims at defining the relative chronology of these structural elements and their impact on the gold distribution at Whale Tail.

4. DISCUSSION AND PRELIMINARY INTERPRETATION

Three structural domains were interpreted from the detailed diamond drill core fabric descriptions : (1) a southern domain (SD) comprising transitional to calc-alkaline ultramafic and mafic volcanic rocks south of the mineralized sequence, (2) a central sedimentary sequence (CSS) comprising orthochemical (iron formation and chert) and clastic rocks (greywacke) hosting most of the mineralization at Whale Tail, and (3) a northern domain (ND) comprising tholeiitic komatiites intercalated with silicate-facies iron formations north of the CSS.

The southern domain is characterized by the presence of a strong schistosity, penetrative crenulation cleavages and fold interference figures, particularly in ultramafic and mafic volcanic rocks near the CSS contact. The central sedimentary sequence is characterized by a strong banding and folding associated with subtle axial planar fabrics outlined by often recrystallized quartz and amphibole veinlets. Mineralization in the CSS is mostly confined to chert units with favourable rheological and chemical properties. The northern domain is characterized by discrete corridors of strong schistosity in an otherwise weakly foliated mass where primary textures such as spinifex may have been preserved.

The poor outcrop exposure and few observations recorded in outcrop and oriented diamond drill core means much of the interpretations provided in this study rely on the proper correlation and interpolation of the multiple fabrics described in unoriented diamond drill core. Without known beta angle measurements for such fabrics, projecting alpha angle measurements for these fabrics onto transversal sections implies an uncertainty inversely proportional to the alpha angle measurements.

Furthermore, fabrics described in diamond drill core often show examples of diamond drill core-scale cleavage refraction, contributing to the uncertainty regarding the proper correlation and interpolation of multiple fabrics at the scale of the transversal section. Observations suggest important structural controls on mineralization, in line with epigenetic models.

5. CONCLUSIONS

Work carried out to date suggests:

1. Important structural and lithological controls on mineralization
2. A northeasterly plunging asymmetrical fold associated with a strong foliation (main schistosity); and
3. A northwest verging, shallowly plunging overturned fold associated with an axial planar fabric coinciding with the orientation of discordant mineralization corridors.

Further work will help define the relative chronology of structural elements and how they control the geometry and distribution of gold mineralization at Whale Tail.

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