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The mantellic connections of Neoarchean sanukitoid porphyry gold deposits, Abitibi, Canada

Jébrak, M., Azevedo, C., Fayol, N.

Dpt. Sciences de la Terre et de l'Atmosphère, Université du Québec à Montréal, CP 8888, succ. Centre-Ville Montréal (Québec) H3C 3P8 Canada

Most of the gold deposits in Archean greenstone belts have been attributed to the syn-orogenic gold deposit model. However, more and more deposits appear to be associated with Neoarchean granitic intrusions that include early TTG and younger granodiorite-syenite plutons. In the Abitibi greenstone belt, gold may occur as large stockwork networks in an intrusion (Beattie, Kiena), as low grade disseminations in an intrusion (Canadian Malartic), and as magnetite replacements (Lake Bachelor) at the contact of an intrusion, as well as in syntectonic quartz veins [1]. These small porphyritic intrusions are associated with syntectonic sedimentary basins and major fault zones that developed between 2680-2668 Ma. Such magmatism has collectively been referred to as sanukitoids *s.l.* [2]. It includes sanukitoids *s.s.*, i.e. LILE- and LREE-rich diorites with high Mg# and more differentiated granodiorite-granite to syenite with high Sr, Sr/Y, and La/Yb, and Eu/Eu* close to unity.

A compilation of 400 fresh rocks analyses allows recognition of two major groups of plutons: (1) dark sanukitoids, representing a magnesio-potassic association, and (2) more leucocratic alkali granites. Both groups of plutons are oxidized, have been emplaced within the same time frame, and show the same structural controls. Major element compositions show that the plutons exhibit a compositional range from ultramafic to felsic, in which the alkali granites are more silica-rich than the sanukitoids. The two suites can be clearly distinguished on the basis of their REE content and element ratios. Moreover, they have contrasting magnetic signatures; sanukitoid suites are characterized by a positive magnetic anomaly centered on the intrusion, whereas alkali granites present a doughnut shape on the magnetic survey, with a magnetic halo surrounding the pluton [3].

Gold mineralization in the sanukitoid suites occurs mainly within the intrusions in association with the magnetite-rich ± hematite, K-feldspar, sericite, iron carbonate, and pyrite alteration zone of the syenite, without fluorite. Gold mineralization associated with the alkali granite suites occurs mainly outside the intrusion. These intrusions are characterized by telluride-rich mineralization, extensive carbonatization, voluminous K-metasomatism, low total sulfide, and limited hydrolytic alteration. They may contain abundant fluorite, and hydrothermal magnetite forms a halo surrounding the intrusion.

Petrogenetic modeling of these two suites shows that they may reflect distinct differentiation paths from the same mantellic source rocks. Fractional crystallization occurred during the ascent of the magma and subsequent to the final emplacement at the upper-crustal level. The HREE fractionation shows that sanukitoid and alkali granite reflect clinopyroxene- and amphibole-dominated fractional crystallization, respectively. The diversity of the evolved magmas reflects the protracted crystallization of basaltic magmas with variable amounts of added H_2O and fluorine.

The two styles of gold mineralization illustrate distinct behaviors of gold in alkaline magmas. In the sanukitoid suites, gold remains associated within the dry magma, and is liberated at the sub-solidus stage as micro-particles within the pluton. Although the average grade of these early magmatic

abundances is largely uneconomic at present, remobilization of the gold by CO_2-H_2O rich fluids produces orogenic gold deposits. In the alkali granite suites, the destruction of the early mantellic association during a wetting stage (H_2O, F) allows the transfer to peri-plutonic hydrothermal systems.

References:

[1] Robert F (2001) Mineralium Deposita 36: 503-516

[2] Laurent O et al. (2014) Lithos 205: 208-235.

[3] Fayol N et al. (2013) Mineralogical Magazine 77: 1068.