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Timiskaming sedimentary and intrusive rocks at Kinross Park, Kirkland Lake, Ontario

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Introduction

Kirkland Lake in northern Ontario represents one of the major orogenic gold districts of the southern Abitibi greenstone belt. The district is located within an east-trending 3–5 km wide belt of Timiskaming sedimentary, volcanic, and intrusive rocks bounded to the south by the Larder Lake-Cadillac fault zone. To the north. the Timiskaming deposits unconformably overly volcanic rocks of the Blake River assemblage (Thomson, 1948; Ispolatov et al., 2008; Poulsen, 2017). The Kirkland Lake district has a total gold endowment of ~30.7 Moz (Monecke et al., 2017).

This contribution comprises a detailed map (Fig. 1) and description of a small glacially-polished exposure (Fig. 2a) that highlights the intricate contact relationship between Timiskaming sedimentary and intrusive rocks. The outcrop is composed of clast-supported cobble conglomerate and lenses of sandstone intruded by augite syenite (nomenclature after Thomson, 1950). The intrusion crosscuts bedding at high angles and locally occupies bedding contacts. The beds of cobble conglomerate and sandstone strike to the north-east and are steeply dipping.

The outcrop described here is located along the walking path on the west side of the pond in Kinross Park close to downtown Kirkland Lake (UTM Zone 17, 570925 m.E., 53332710 m.N.). It was first exposed during construction of the walking trail in 2012. The outcrop is easily accessible making it a suitable field trip stop. This is particularly the case as the Kinross Park outcrop is only ~350 m south of the large outcrop area at the location of the former Don Lou motel, now occupied by a Veterans Affairs Canada building, which exposes key relationships between Timiskaming volcanic and intrusive rocks (cf. Poulsen, 2017).

Polymict Conglomerate

The Kinross Park outcrop largely consists of polymict clast-supported conglomerate (Fig. 2b). The conglomerate is poorly sorted and exhibits a bimodal size distribution of medium cobbles and coarse pebbles. The pebble and cobble clasts are dominantly rounded to subrounded and have varying degrees of sphericity. Clast imbrication produces an apparent bedding parallel fabric. Rhyolite (~41%), alkalic rocks (~21%), and basalt (~18%) are the most prevalent clast types. Lesser amounts of ultramafic rocks (~9%), trondhjemite, tonalite, and granodiorite (~4%), and banded iron formation (~2%) are also present. Partially altered komatiite clasts sometimes display remnant spinifex texture (Fig. 2c). A small clast of rhyolite porphyry crosscut by a 5 mm wide quartz-magnetite vein was identified (Fig. 2d) and sampled for the study by Hufford (2015). The vein was truncated at the clast margins, indicating that it represents an early vein formed prior to deposition of the conglomerate.

Arkosic Sandstone

The sandstone occurs as lenses and beds that range in thickness from 5 to 50 cm (Fig. 2e). Thin planar laminations are ubiquitous, and planar cross-bedding is locally present. Along the basal contacts with the conglomerate, the laminations have an undulating morphology that mirrors the irregular shape of the underlying conglomerate surface. Rounded pebble and cobble clasts locally occur within the sandstone, which is dominantly composed of medium-grained sub-rounded sand-sized particles. The sand-sized grains consist of plagioclase, quartz, potassium feldspar, and lithic fragments. The presence of chlorite gives the sandstone a greenish color.

Augite Syenite

The augite syenite is a coherent coarse-grained equigranular intrusive rock composed of augite and minor plagioclase (Fig. 2f). It occurs as a dike and irregularly shaped branching sill complex. The sills appear to follow bedding contacts and terminate within the sedimentary rock. Clasts from the conglomerate are locally incorporated in the sill on the northwest margin of the outcrop. Contact metamorphism between the augite syenite and the host rock was not observed. The augite syenite in this outcrop is similar in composition and texture to the augite syenite at the Don Lou outcrop (cf. Poulsen, 2017). However, no rhythmic compositional banding of feldspar syenite and augite syenite is observed in the Kinross Park outcrop.

Depositional Environment

Based on the presence of planar laminations, cross-bedding, clast imbrication, crude stratification in the conglomerate, lenticular beds, and the abundance of rounded clasts, the conglomerate and sandstone facies of the Kinross Park outcrop are interpreted as braided river deposits (cf. Miall, 1977). This is consistent with previous interpretations of similar conglomerate facies in the Kirkland Lake area (Hyde, 1980; Mueller et al., 1994). Mueller et al. (1994) also suggested that the conglomerate-sandstone facies may represent alluvial fan deposits. However, this interpretation is not favored at the Kinross Park outcrop as there is no evidence for deposition by debris flows or sheet floods (cf. Blair and McPherson, 1994).

Conglomerate and sandstone deposited in a marine setting have also been documented in the Kirkland Lake area (Hyde, 1980). However, this type of conglomerate would be interstratified with sandy turbidites. Given the apparent absence of such turbidites in the vicinity of the outcrop, a deeper marine setting of deposition seems unlikely, but cannot be entirely ruled out due to the limited size of the outcrop investigated.

The interpreted occurrence of braided river deposits at the Kinross Park outcrop signals that there was a high availability of bed-load sediment relative to suspended load sediment (Chitale, 1970; Friend and Sinha, 1993), implying that sediment supply was abundant (Lunt and Bridge, 2004).

Clast Sources

The assortment of different clast types reflects variations of the exposed lithologies during sedimentation. While rounded morphologies signal significant transport distances or high energies (Mills, 1979), local lithologies were important sources, as highlighted by the presence of alkalic igneous rocks, which are abundant in the Kirkland Lake area. Previous researchers have also noted that probable sources of the different clasts type are present within 15 km of their current locations (Legault and Hattori, 1994). Round Lake batholith (2697–2698 Ma) has been inferred as a likely source of tonalite and trondhjemite clasts (Legault and Hattori, 1994). The presence of these clasts suggests that portions of the hinterland near the batholith must have been significantly eroded at the time of sedimentation and that transport of the clasts would have occurred from south to north in terms of modern-day geography.

Post-Depositional Processes

Based on the crosscutting relationships, the conglomerate and sandstone were intruded by the augite syenite after deposition. Compositionally similar Timiskaming-aged intrusions are present throughout the Kirkland Lake area (Ispolatov et al., 2008) and are exposed at the Dou Lou outcrop (Poulsen, 2017). The bedding of the conglomerate and sandstone differs slightly (~20°) from the bedding orientation of nearby outcrops, possibly suggesting that the intrusion of the augite syenite has resulted in block rotation.

There are several post-depositional en-echelon faults that offset the conglomerate and sandstone. These faults are interpreted to post-date deposition of the sedimentary rocks. All lithofacies have been affected by iron carbonate alteration, which is most strongly developed in the conglomerate in the northeastern corner of the outcrop. The alteration is most likely related to the formation of the orogenic gold deposits at Kirkland Lake. The former Lakeshore gold mine is located close to the Kinross Park outcrop.

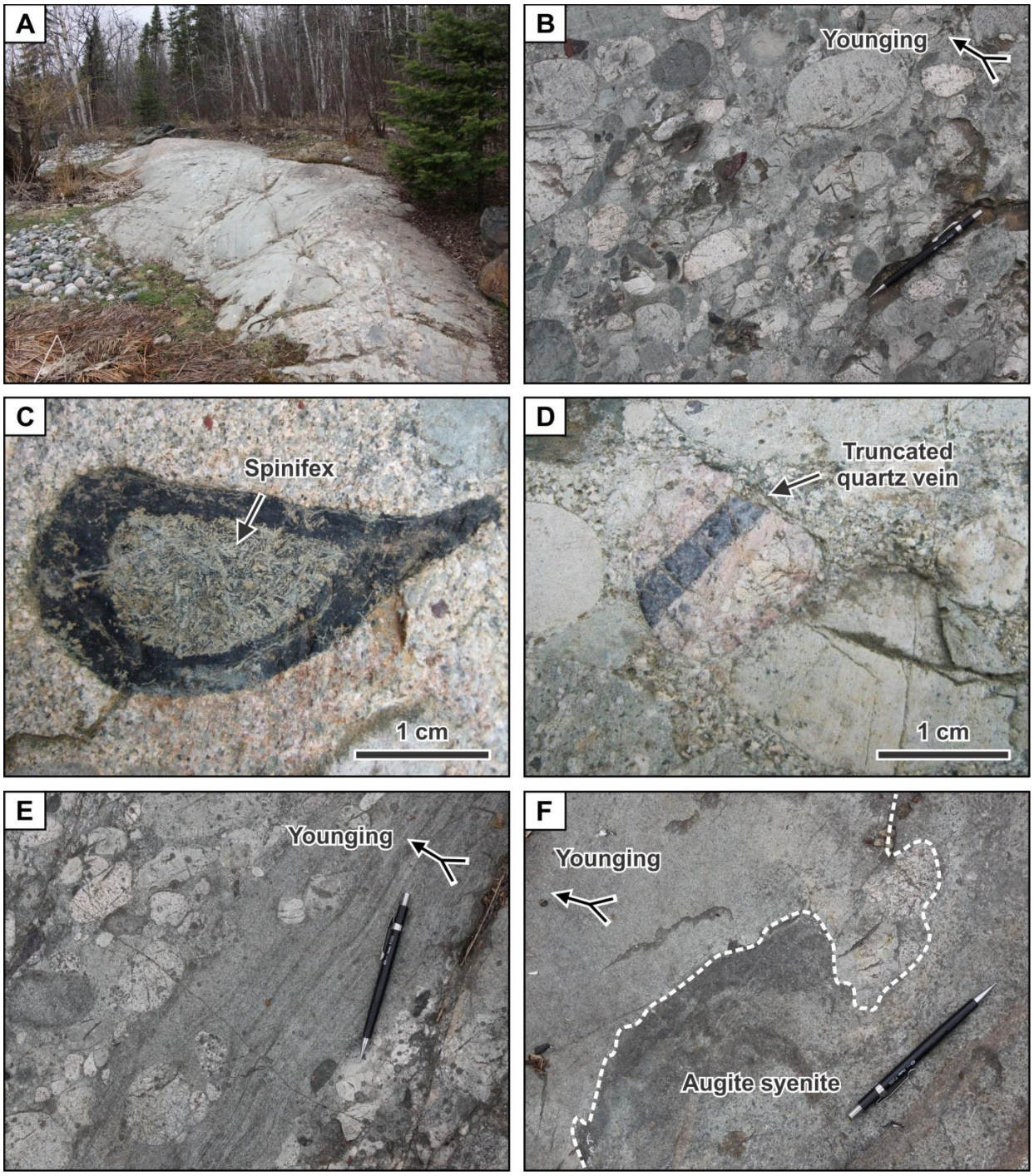

Fig. 2: Timiskaming sedimentary and intrusive rocks at Kinross Park, Kirkland Lake. A. Glacially polished outcrop. B. Polymict conglomerate comprising pebble and cobble clasts that are rounded to subrounded and have varying degrees of sphericity. Note pencil for scale. C. Small komatiite clast showing spinifex texture. D. Quartz-magnetite vein in a porphyry clast. The vein is truncated at the clast margin suggesting that it formed prior to deposition of the conglomerate. E. Arkosic sandstone containing rounded pebble and cobble clasts. Note pencil for scale. F. Augite syenite in contact with the arkosic sandstone. Note pencil for scale.

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