CLARENCE STREAM GOLD DEPOSIT

Introduction

The Clarence Stream gold deposit lies east of St. Stephen in southwestern New Brunswick (Fig. 1, 4, 6). Exploration activity near Clarence Stream began shortly after prospector Reginald Cox Jr. discovered highly mineralized boulders in the area during the fall of 1999. Since then, Freewest Resources Canada Incorporated has optioned the property and launched a comprehensive program that includes geological mapping, soil and till geochemical sampling, IP and magnetometer surveys, trenching, and extensive drilling. The company's exploration efforts have identified two major mineralized zones along the northwestern margin of the Saint George Batholith. These two zones, which have contrasting styles of mineralization, are referred to as the Main Zone and the Anomaly A Zone (Fig. 6).

Structural Setting of Gold Deposit

The Clarence Stream gold deposit is localized along the Sawyer Brook Fault, a regional, high-strain zone marking the approximate boundary between the New River and St. Croix terranes (discussed earlier under *Tectonic Zonation*). An accretionary complex related to the juxtapostion of these terranes in the Late Ordovician is assumed to lie concealed beneath Silurian volcanic and sedimentary rocks of the Mascarene Group and Late Silurian–Late Devonian plutons of the Saint George Batholith (Fig. 4, 6, 7).

Periodic reactivation along terrane boundaries is a well known phenomenon in the evolutionary development of the Appalachian Orogen (Williams and Hatcher 1982). Reactivation of deep-seated structures in southern New Brunswick is thought to have occurred during accretion of the Kingston volcanic arc in the Late Silurian and Early Devonian. The Sawyer Brook Fault, which separates Ordovician rocks of the Cookson Group to the northwest from Silurian rocks of the Mascarene Group to the southeast, is interpreted to be a surface manifestation of one such structure. Mafic and felsic magmas would have used deep crustal structures within the accretionary complex to rise to higher crustal levels, where they coalesced to form the composite Saint George Batholith (Thomas and Willis 1989; McLeod 1990; Whalen et al. 1994).

Main Zone

The Main Zone is found immediately southeast of the Sawyer Brook Fault, 3 km southeast of the Anomaly A Zone on the northwest side of the fault (Fig. 6, 11, 12). Mineralization in the Main Zone is structurally bound in a brittle-ductile shear zone that is associated with a

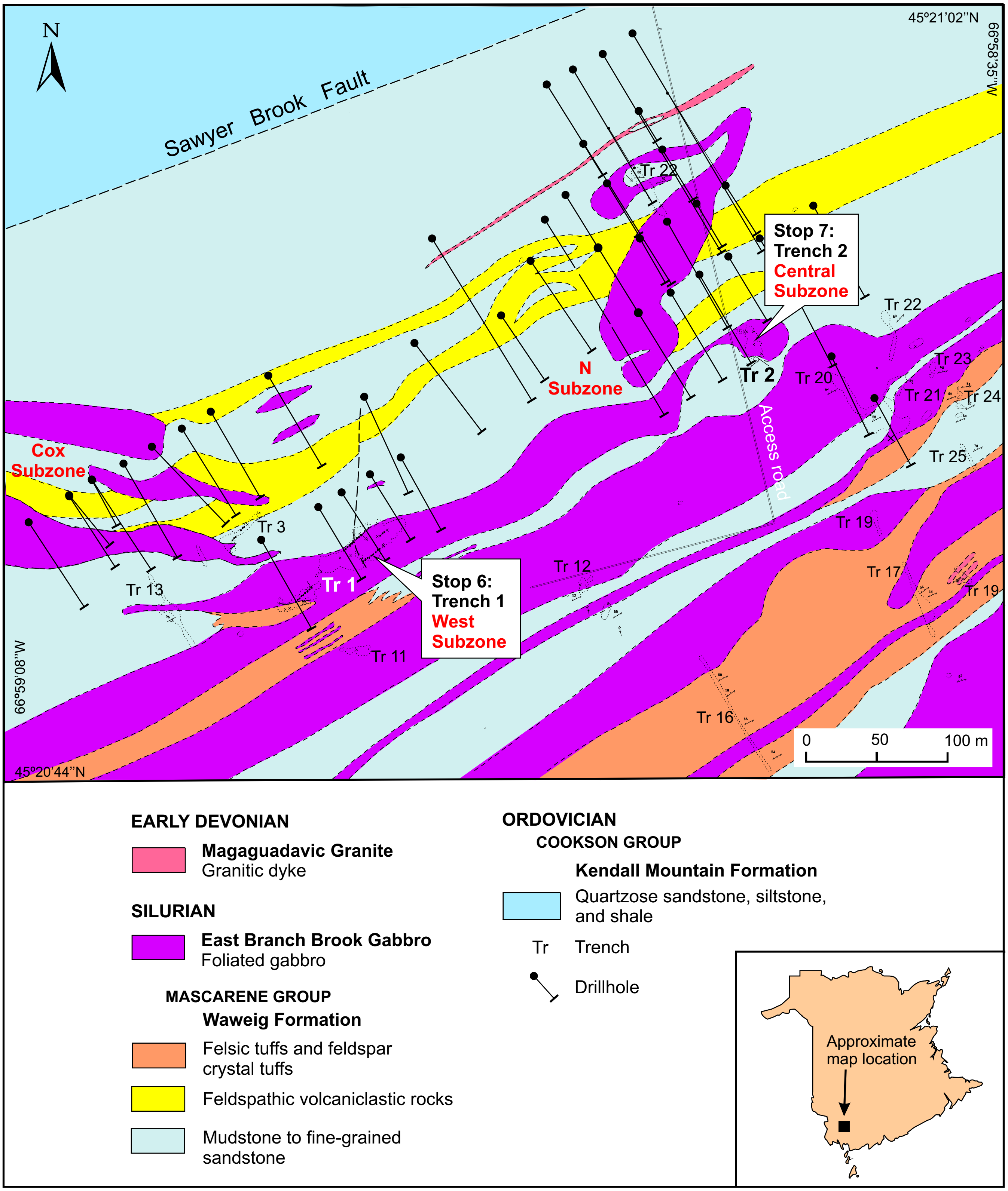

Figure 11. Geology of the Cox, West, N, and Central subzones of the Main Zone, Clarence Stream deposit (modified after Thorne et al. 2004c). The field distance between Figure 11 and Figure 12 (facing page) is about 400 m. Figure 6 shows the location of Figure 11.

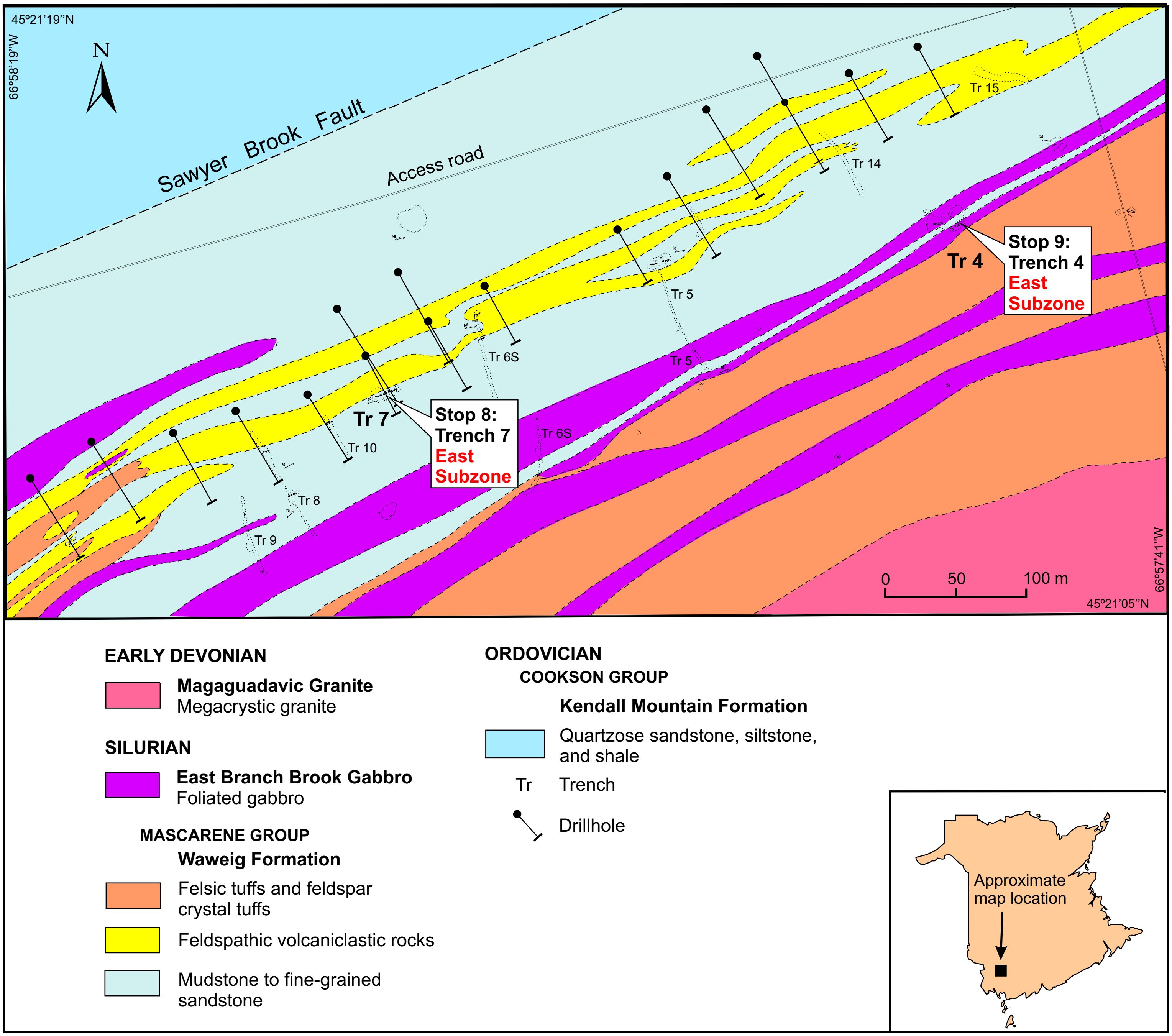

Figure 12. Geology of the East Subzone of the Main Zone, Clarence Stream deposit (modified after Thorne et al. 2004b). The field distance between Figure 11 (facing page) and Figure 12 is about 400 m. Figure 6 shows the location of Figure 12.

secondary splay of the Sawyer Brook Fault (Thorne and Lentz 2001a, 2002, 2003). The splay parallels the intrusive contact with the Magaguadavic Granite to the south and transects Silurian sedimentary and volcanic rocks of the Waweig Formation. This stratigraphic sequence has been intruded and contact metamorphosed by several injections of gabbroic dykes of the East Branch Brook Gabbro (Thorne and Lentz 2001b) during an event that occurred before emplacement of the Early Devonian Magaguadavic Granite of the Saint George Batholith (McLeod 1990).

The Main Zone encompasses several mineralized subzones, referred to as the Cox, West, N, Central, and East subzones (Fig. 11, 12). Free gold typically occurs within parallel, northeast-trending, steeply dipping quartz veins hosted by cordierite-biotite-muscovite-bearing, schistose sedimentary rocks of the Early Silurian Campbell Point Member (Waweig Formation), and within Silurian gabbroic dykes of the East Branch Brook Gabbro (Fig. 11, 12). Gold also occurs as disseminations within the gabbroic wall rocks and in mineralized, composite pegmatite-aplite dykes that are late fractionates of the Magaguadavic Granite (Thorne et al. 2002b).

The stratified units are dominated by a well developed shear fabric that Castonguay et al. (2003) attribute to heterogeneous D_3 deformation. These authors interpret the Sawyer Brook Fault as a late-D_3, dextral, strike-slip structure that cuts the southeastern limb of the regional-scale, northeast-trending St. David Antiform (Fig. 6), which itself is an F_3 structure and a manifestation of the regional D_3 event. Detailed structural investigations of the Main Zone (Park 2001, 2003; Park et al., in press) indicate that dextral and later dip-slip movement along the brittle-ductile shear zone boudinaged and rotated the mineralized quartz veins. The dip-slip movement possibly resulted from isostatic readjustment related to cooling of the Magaguadavic Granite.

The vein material has been extensively reworked subsequent to the deposition of quartz and associated mineralization, as evidenced by the saccharoidal texture, lack of primary depositional features, and brecciation of some veins. Slight folding and offsetting of these veins is obvious in small, post-mineralization, north- to northwest-trending shear zones. Mineralization is better preserved in quartz veins that were shielded by the more competent gabbroic bodies at the West Zone (Fig. 11), whereas quartz veins hosted within fissile sedimentary units at the East Zone (Fig. 12) are boudinaged and less continuous. Overall, the quartz veins exhibit textures ranging from mylonitic to brecciated and were formed at various stages of episodic deformation. The veins also show late development of an annealed, saccharoidal texture that resulted from thermally induced recrystallization of strained quartz. Samples of muscovite from quartz veins at the Main Zone yielded ^{40}Ar-^{39}Ar ages of 389.3 ± 3.5 Ma and 388.8 ± 3.6 Ma, numbers that enable a minimum date to be set for the timing of gold mineralization (Davis et al. 2004).

Mineralization at the Main Zone is broadly representative of a typical Au-As-Sb metal association, consisting mainly of arsenopyrite, pyrrhotite, pyrite, berthierite, minor chalcopyrite, sphalerite, and a variety of Sb-bearing minerals. Geochemically, the gold has a positive correlation with Ag, Bi, Cd, Te, S, and Cu, similar to the geochemical signature of intrusion-related gold deposits (Thompson et al. 1999; Lang et al. 2000; Thompson and Newberry 2000; Lang and Baker 2001). Alteration associated with the gold mineralization persists as K-metasomatism within mafic rocks and as Na-metasomatism within sedimentary and volcanic rocks (Thorne and Lentz 2002).

Geochemical, geochronological, and isotopic investigations indicate that the source of gold mineralization at the Main Zone was fluids evolved from the cooling Magaguadavic Granite (Thorne et al. 2002b; Thorne and Lentz 2003; Thorne 2005). The best evidence to support this inference can be seen at Stop 9, where granitic dykes grade laterally into gold- and sulphide-bearing quartz veins. These dykes are geochemically similar to late-stage fractionates of the Magaguadavic Granite (Thorne and Lentz 2002). It is thought that Au-As-Sb-Bi mineralization was deposited within dilatant areas of the shear zone from high temperature (> 300ºC and < 375ºC), chlorine-bearing fluids whose characteristics were consistent with a mesothermal system (Thorne and Lentz 2003). Pressure fluctuations likely were the predominant control on mineralization (that is, fault-valve action); changes in redox state of the fluids, temperature, pH, and fluid-wallrock interaction may also have influenced gold precipitation (Thorne 2005).

Anomaly A Zone

Mineralization in the Anomaly A Zone is hosted by polydeformed quartzose sandstone, siltstone, and shale of the Kendall Mountain Formation (Fig. 6). Several mineralized subzones have been identified within the zone, namely the AD, MW, 93, and Murphy subzones (Fig. 13).

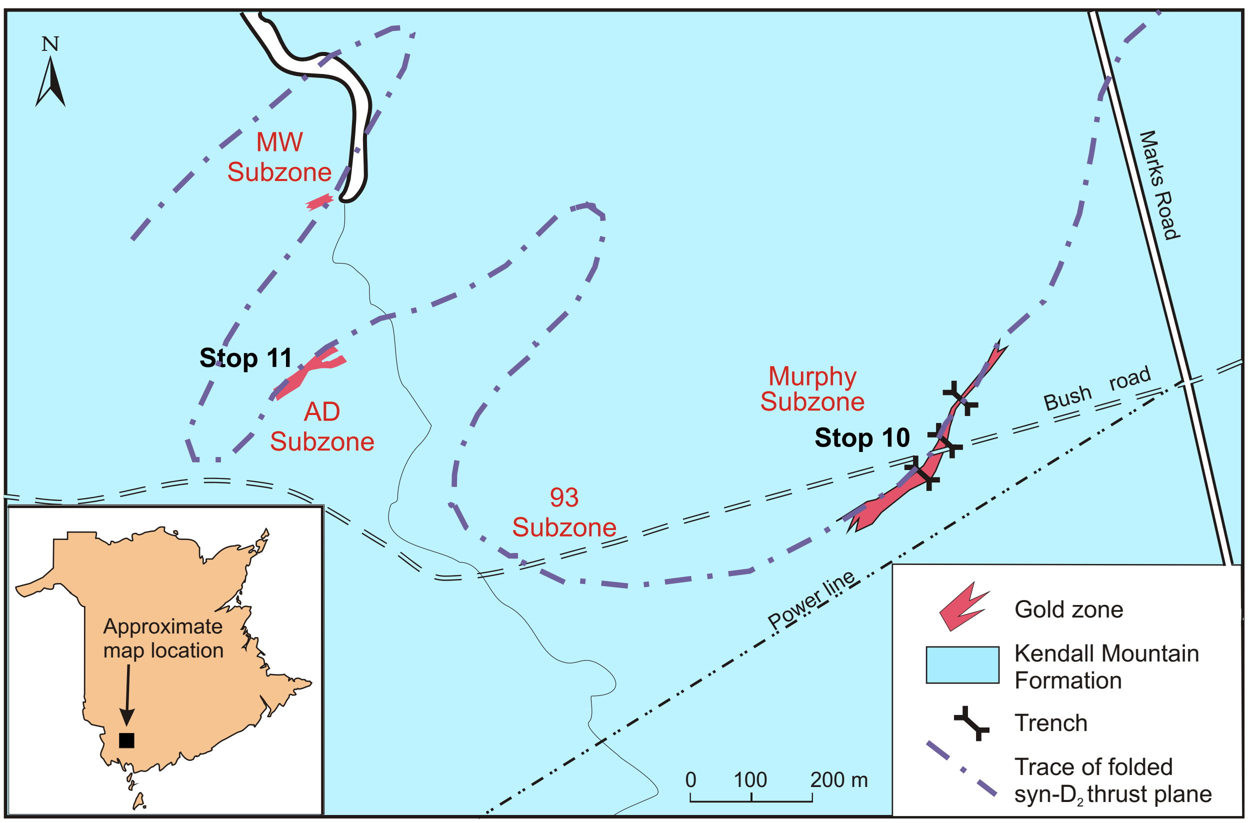

Figure 13. Plan view of the Anomaly A Zone, Clarence Stream deposit, indicating the position of the AD, MW, 93, and Murphy subzones (modified after Watters et al. 2003). Figure 6 shows the location of Figure 13.

The style of mineralization in the Anomaly A Zone differs substantially from that in the Main Zone. Mineralization at Anomaly A occurs in stockwork and auriferous quartz veins within shallowly dipping, brittle-ductile, high-strain zones that generally strike east-northeast (Lutes et al. 2003). The high-strain zones are tabular shaped, several metres thick, and appear restricted to the limbs of mesoscopic to megascopic, isoclinal F_2 folds. These late-D_2 shears are deformed and overprinted by D_3 and D_4 open-folding events. Mineralized intervals at the AD and MW subzones dip in opposite directions and are interpreted to occupy opposing limbs of a broad synform associated with the D_3 event (Castonguay et al. 2003; Watters et al. 2003). Recent drilling by Freewest Resources Canada Incorporated indicates that the 93 Subzone may be a direct continuation of this structure (Fig. 13).

The Anomaly A Zone features at least three main stages of quartz veining. Gold occurs predominantly in the middle quartz-sulphide vein stage associated with pyrrhotite, arsenopyrite, pyrite, and stibnite; here, minor amounts of gold (1–2 g/t Au) are contained within altered sediments. This metal signature is similar to that of the Main Zone, except that the Anomaly A signature lacks Bi minerals and shows abundant Sb. The variation could be explained in terms of geochemical zonation and differing proximity of the two zones to a gold-generating granitic source.

Unlike mineralization at the Main Zone, which lies within 200 m of the Early Devonian Magagudavic Granite, gold mineralization at the Anomaly A Zone apparently has no close relationship to an intrusive body. Trenching and drilling have not yet exposed granitic lithologies spatially associated with mineralization at this location, although geophysical data suggest that a granitic mass of unknown age and affinity underlies the area at relatively shallow depths (Thomas and Willis 1989; King and Barr 2004). The nearest known intrusions are the Sorrel Ridge Granite and Pleasant Ridge Granite that are exposed just west and east, respectively, of the Anomaly A Zone (Fig. 6). The higher fluorine-to-chlorine ratio in these satellite plutons decreases their potential as a source of gold-bearing fluids (Yang and Lentz 2005).

Structural studies of the Anomaly A Zone indicate that its gold mineralization is contemporaneous with late-D_2 shears (Castonguay et al. 2003). Greisen veins overprinting auriferous veins in the AD Subzone are interpreted to be related to the Sn-bearing Pleasant Ridge Granite; this would restrict the timing of gold mineralization in the Anomaly A Zone to pre-Late Devonian (Watters et al. 2003). According to Watters et al. (2003), similarities in ore mineralogy and structural history between the Anomaly A and Main zones suggest that the two zones represent distal and proximal components, respectively, of a single, granite-related, gold-mineralizing system. Previous research at the Main Zone suggests this system is contemporaneous with emplacement of the Early Devonian Magaguadavic Granite (Thorne et al. 2002b; Thorne and Lentz 2003; Davis et al. 2004).