8. GRANITE-ASSOCIATED DEPOSITS: EAST KEMPTVILLE & DUCK POND

East Kemptville Sn mine in southwestern Nova Scotia.

8.1 INTRODUCTION

Most of the granite-related mineral occurrences in southwestern Nova Scotia are spatially associated with the extensive South Mountain Batholith (SMB). This is a composite intrusion of older biotite granodiorite and granodiorite porphyry phases which are cut by smaller, younger intrusions of two-mica monzogranites and leucomonzogranites of Devono-Carboniferous age. Smaller plutons of similar composition and age occur east of this major pluton and include the Musquodoboit Batholith (MacDonald & Clarke, 1985), the composite mafic/felsic Liscomb Complex (Giles & Chatterjee, 1987a) and several scattered smaller intrusions in the eastern Meguma Terrane.

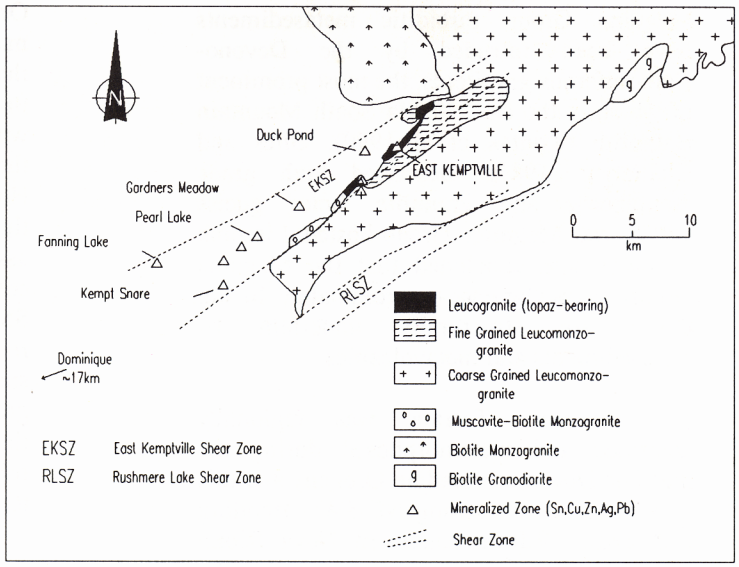

Figure 27. *Geological setting of southwest Nova Scotia tin domain.*

Two areas of economically significant mineralization have been identified within this granitic terrane. The Millet Brook uranium-silver discovery, near the eastern end of the SMB, has been placed under closure due to a moratorium on uranium exploration. The southwestern Nova Scotia tin domain of Chatterjee (1983) contains a number of deposits, the best known being the East Kemptville Mine which was in production from 1985 to January 1992.

Two classes of Sn-bearing deposits are present within this metallogenic environment. **Class 1** deposits are those hosted within the granitic rocks proper (East Kemptville and Kempt Snare Lake), whereas **Class 2** deposits are hosted within the Meguma Group metasediments and include Duck Pond, Dominique and Pearl Lake.

8.2 REGIONAL GEOLOGY

The southwest Nova Scotia base metal zone is contained within the Meguma Terrane of southern Nova Scotia (Fig. 27), which can be regarded as the most eastern (or outboard) terrane of the Appalachian Collage (Keppie, 1987). The widespread Cambro-Ordovician Meguma Group turbiditic metasediments have been intruded by the Devono-Carboniferous granitoids, the most prominent of which is the ca. 370 Ma South Mountain Batholith (Kontak et al 1990). Giles and Chatterjee (1987a) described high grade amphibolite and granulite facies gneiss within the Meguma Group-hosted Liscomb Complex and concluded that the Meguma Group metasediments (approximately 10 km thick) are structurally underlain by metasediments and metavolcanics.

This Meguma Terrane was regionally deformed and metamorphosed during the mid-late Devonian Acadian Orogeny and this is reflected in the strong NE-SW - trending fold axes. Within southwest Nova Scotia northeast-trending structures, post-dating the regional Acadian orogeny, are present as well defined kilometre-wide (1-4 km) shear zones in both the metasediments and the granitoids.

The East Kemptville Shear Zone (EKSZ on Fig. 27) is a 1-4 km wide northeast-trending zone of intense ductile ($\pm$ brittle) deformation transecting the Meguma metasediments and the SMB granitoids and paralleling the northwest contact of the batholith. Various age determinations suggest that this zone was active from Devono-Carboniferous to Permian times.

The western part of the SMB is referred to as the Davis Lake Complex (McAuslan et al., 1980; MacDonald et al., 1989). This composite pluton (five distinct phases are recognized by MacDonald et al., 1989) intrudes the Meguma Group metasediments (Fig. 28) and all the granitic phases contain variably developed deformational fabrics.

There is some debate as to the age of the intrusions associated with the introduction of the mineralization. Thus, Sangster (1990) describes a second group of smaller intrusions of broadly similar composition locally intruding the contact zone between the SMB and the Meguma (Cambro-Ordovician) metasediments at the western margin of the Davis Lake Complex. He states that these are 30-60 million years younger than the major intrusion and notes that it is with these later intrusions that the majority of the mineral occurrences are associated. However, Kontak and Cormier (1991) state that the East Kemptville leucogranite and associated mineralization were emplaced coincidentally with intrusion of the main SMB, and Kontak and Chatterjee (in press) reinforce these findings with a Pb isotope study of the leucogranites and mineralized greisens. Kontak et al. (1990) suggest that the younger ages quoted in Sangster (1990) reflect the effects of overprinting by later tectono-thermal events.

The mineral deposits associated with these plutons are located on the peripheries of the intrusions and may be hosted in the granite or in the intruded Meguma metasediments (Fig. 28). The intrusions are 'specialized', i.e. they contain distinctive trace element values diagnostic of potentially metalliferous granites. Tischendorf (1977) and Chatterjee (1983) recognized stanniferous and uraniferous types and proposed several metallogenic domains.

It was Chatterjee (1983) who first introduced the term southwest Nova Scotia tin domain with the following main features:

1. Numerous occurrences of tin and associated base metals,

2. Coincidence of the mineralized zones with an areally extensive shear zone, the East Kemptville Shear Zone (EKSZ), and

3. The presence of highly evolved felsic intrusions along the western margin of the SMB.

For the purposes of this study two classes of granite-associated deposits are recognized within this environment. **Class 1** deposits are those occurring within granitic rocks and exemplified by East Kemptville (the class example) and Kempt Snare Lake. The **Class 2** deposits are hosted within the Meguma Group metasediments and include Duck Pond (the class example), Dominique and Pearl Lake.

8.3 GRANITE - HOSTED : EAST KEMPTVILLE DEPOSITS

8.3.1 Location and Access

The East Kemptville deposit is located some 50 km northeast of Yarmouth in Yarmouth County, Nova Scotia, on NTS map sheet 21A-4A and approximately at 65° 41' W and 44° 06' 10" N. Access is by paved highway 348 to Kemptville and then by mine access road for 8 km to the mine site.

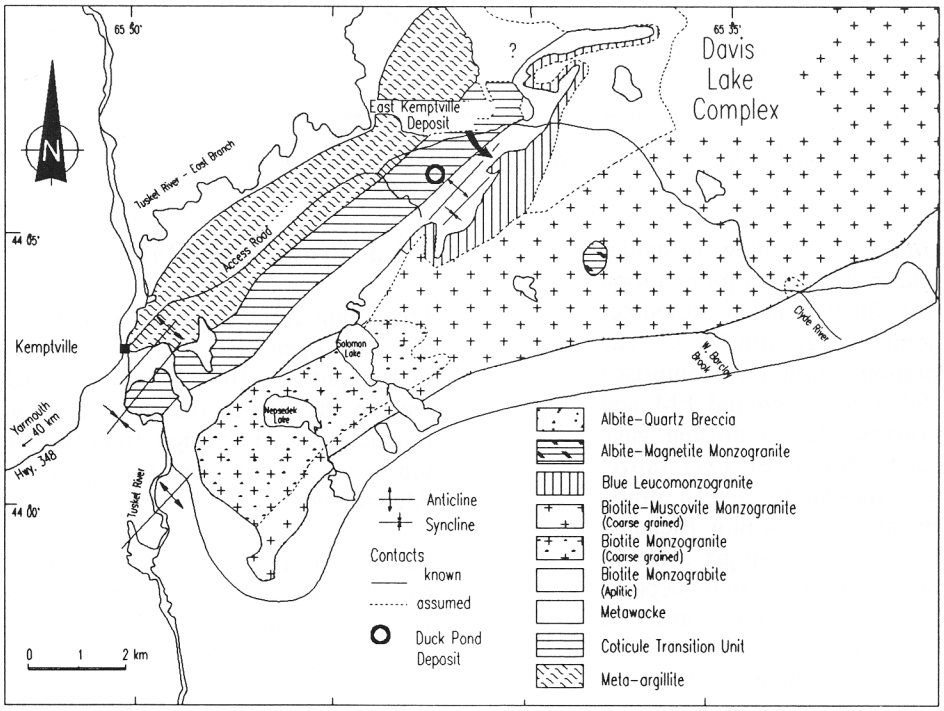

Figure 28. *Geological map of Davis Lake Complex.*

8.3.2 Exploration History

Small scale gold mines were known in Yarmouth County from 1881 to 1928 and production was actually achieved from two of these deposits. Though literature references relating to tin exploration and mining in the New Ross area of southern Nova Scotia in the early 1900s are numerous (Messervey, 1933), it was only in 1975 that the first occurrence of tin was recorded in the southwest part of the province.

In the early 1970s Maritime Explorations Ltd. (MEX) identified tungsten and sphalerite in thin granitic veins while drilling for gold at Kemptville (McAuslan et al., 1980). Further exploration of other granitic intrusions led to the discovery of boulders of chloritized sediments containing tin and base metals in highway fill and in material being used in wharf construction. Follow-up studies traced these boulders to a gravel pit and soon after (late 1976) Shell Canada Resources entered into a joint venture with MEX. The ensuing exploration program comprised airborne EM, followed by ground EM and magnetometer surveys. Initial drilling gave weak values and by November 1977 thirty-five drill holes had indicated a zone of erratic tin and base metal values within Meguma Group metasediments at Dominique, some 40 km southwest of the East Kemptville deposit. The style of mineralization was similar to that in the float boulders and, though uneconomic, the Dominique discovery encouraged Shell to expand a regional till geochemical sampling program in southwest Nova Scotia.

By mid 1978 a significant Sn geochemical anomaly had been outlined in till samples in the area immediately east of East Kemptville. Follow-up work revealed cassiterite-bearing granitic boulders with sphalerite and chalcopyrite. Further prospecting delineated an area 2 km by 0.5 km with abundant mineralized boulders.

Diamond-drilling commenced in 1979 and by early 1980 Shell estimated a drilled reserve of 25 M tonnes @ 0.2% Sn to a depth of 100 m (McAuslan et al., 1980). Rio Algom Ltd. acquired the deposit in 1982 and preproduction reserves were 56 M tonnes @ 0.165% Sn at a 0.08% Sn cut-off (Moyle, 1985). Open pit mine production began in 1985 and though maintaining a milling rate of 10,000 tpd the mine was closed down in January 1992 due to continuing low tin prices.

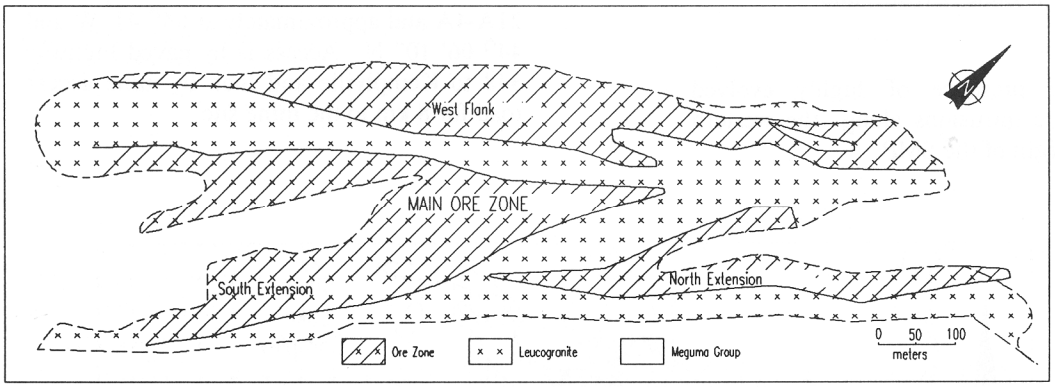

Figure 29. *East Kemptville Sn deposit - geology and distribution of ore zones.*

8.3.3 Production Data

Production from the East Kemptville Mine was by open pit methods and a mill throughput of 10,000 tpd was achieved. During the life of the mine the following products were recovered from 18.8 million tonnes of ore milled (pers. comm., Rio Algom, 1992).

Sn -in concentrate:	21,331 tonnes
Cu -in concentrate:	1,582 tonnes
Zn -in concentrate:	2,009 tonnes
Ag -in Cu concentrate:	2,139 kg (68,720 oz.)

It is estimated that some 26.7 million tonnes of material were removed from the open pit between 1986 and 1991. Head grades for the

first half of 1991 averaged 0.194% Sn and an average monthly production of 740 tonnes of concentrate grading 51.45% Sn was achieved representing a recovery rate of 74%. Zinc recoveries for the same period averaged 9.4% resulting in the production of 140 tonnes of Zn concentrate grading 45.8% Zn from a head grade of 0.256% Zn. Copper concentrates averaged 80 tonnes per month grading 18% Cu and representing a 7.25% recovery from the head grade feed of 0.074% Cu. Silver production for 1989 was 345 kg (11,084 oz) and reported in the Cu concentrate.

8.3.4 Geology and Mineralization

The East Kemptville deposit, a horizontal tabular zone measuring 1500 m long x 500 m wide x 100 m thick, is hosted within a greisenized muscovite-topaz leucogranite along the western contact of the Davis Lake Complex and the Meguma Group metasediments (Kontak et al., 1990) (Fig. 29). The granitic host is characterized by its medium-grained, equigranular texture and Kontak (1987) suggests that the presence of topaz is indicative of a primary magmatic origin. Trace element chemistry and rare earth element data indicate that the leucogranite represents a late stage differentiate of a felsic melt.

Structural fabrics, both ductile and brittle, overprint the leucogranite and greisen lithologies and the deformation has a preferred northeast, subvertical trend.

Kontak et al. (1990) describe two discrete styles of tin mineralization:

Style 1: Disseminated cassiterite ± Fe-Cu-Zn sulphides and graphite in black quartz-topaz greisens. The majority of mineralization is included in this category which is preferentially located in granite/sediment contacts and grade decreases inward from the contacts.

Style 2: This is represented by NE-trending, subvertical to flat, symmetrically zoned, quartz-topaz ± muscovite greisens cored by coarse cassiterite. These occur throughout the deposit within both Style 1 greisens and the fresh leucogranite. Fine disseminated sulphides occur in this greisen type and in paragenetically later, coarse-grained quartz-sulphide veins. These greisen-bordered veins are known over a wide area (15 sq km) but only approach economic viability at East Kemptville.

Chemical data presented by Kontak et al. (1990) indicate mobility of most elements within the greisens and stable isotope studies favour a magmatic source for the sulphur. Oxygen isotope data suggest possible mixing of a primary magmatic and probably meteoric fluids.

The relative ages of the host rock and mineralization have been investigated by several authors since the mid 1980s. The most recent work, by Nova Scotia Department of Natural Resources geologists, indicates initial intrusion and mineralization ca. 370 Ma (Devono-Carboniferous) with four measured tectono-thermal overprintings up to ca. 260 Ma (Permian). This, they suggest, demonstrates that the East Kemptville leucogranite and mineralization are contemporaneous with the intrusion of the South Mountain Batholith.

8.4 METASEDIMENT-HOSTED: DUCK POND DEPOSIT

This deposit, located approximately 2 km west of the East Kemptville mine site, is hosted by northeast-trending, strongly deformed argillaceous and siliceous metasediments of the Meguma Group (Kontak et al., 1990). The deposit covers an area 1.5 km x 1.2 km and has inferred reserves from diamond-drilling of 5.1 Mt @ 0.129% Sn. Associated structural features also trend in a northeasterly direction.

Drilling has outlined three sub-parallel zones of vein and stratabound type mineralization, at least one of which is coincident with an intense shear zone.

Three contrasting styles of mineralization have been described as follows:

Style 1: Stratabound within hydrothermally altered quartzitic sediments with a distinctive alteration mineralogy,

Style 2: Quartz-chlorite-casitterite veins and veinlets, and

Style 3: Silicified and sericitized zones containing pyrite and base metals.

Kontak et al. (1990) note that the tin mineralization is earliest and is associated with chloritic alteration, whereas the base metals (primarily Cu and Zn, and which in part overlap and postdate the cassiterite stage) are associated with argillic alteration. A late stage and intense hematite alteration is also present and all the mineralization is regarded as being of hydrothermal origin.

The Dominique deposit, situated about 5 km east of Yarmouth, was investigated by 89 drillholes and several east-west mineralized zones containing high grade base metal values (0.7% Sn, 2% Zn/ 4.14 m) were intersected.

8.5 ANALOGIES AND EXPLORATION POTENTIAL

The association of tin mineralization in southwest Nova Scotia with a major NE-trending structure is similar to relationships worldwide. Analogies have been drawn (Giles & Chatterjee, 1984) with the deposits in the Hercynian Massifs of Europe and the settings and styles of mineralization are similar. Giles and Chatterjee (1984) suggest that because of these similarities the mineral zoning patterns, so well documented in the European deposits, are valid in southwestern Nova Scotia. Some of the European mines produce, or produced, mainly tungsten, some mainly tin, but virtually all have byproduct base metals.

The strong structural control to the southwestern Nova Scotia deposits is also present in the Millet Brook uranium/Ag deposit at the northeastern end of the SMB. Kontak et al. (1990) point out that though granite cupolas have not been detected beneath all the Meguma Group -hosted deposits, comparison of the mineralogy with that at East Kemptville suggests that granites probably underlie the other mineralized areas. Thus they conclude that the sediment-hosted mineralization within the East Kemptville Shear Zone can be regarded as a near surface manifestation of buried granite cupolas.

This conclusion should be borne in mind when considering the significance of the Eastville Meguma Group sediment-hosted base metal deposit which lies to the north of the surface expression of the Liscomb Complex.

In addition the widespread presence of Cu, Zn and Ag within the East Kemptville and associated deposits suggests that continuing exploration within this hybrid environment for base metal deposits could be successful. In support of this Rogers (pers. comm., 1992) presents new results from till samples in southwestern Nova Scotia which suggest that there is marked dispersion originating from the southern contact of the South Mountain Batholith, to the south of East Kemptville in the vicinity of the Rushmere Lake Shear Zone (RLSZ on Fig. 27)