ST AUSTELL AREA

The St Austell granite has only in recent geological times been unroofed and as а consequence exhibits Sn mineralization associated with roof zones. The granite is also the most extensively kaolinized in Cornubian the Ore Province with three main types 1) megacrystic granite, 2) lithium granite, and 3) fine biotite granite. There were two stages of magmatic activity, firstly the intrusion of biotite granite to be followed by non-megacrystic lithiummica granite. alteration Metasomatic megacrystic produced lithium-mica granite and



pockets of fluorite-rich granite. Hydrothermal activity produced explosive breccias, quartztourmaline rock and greisenization. There are small satellite stocks to the north and northeast of the main mass but the metamorphic aureole is smoothly elliptical, an indication of a shallow depth to the main mass. The country rock is of Devonian metasediments of mainly metapelites with calc-silicates striking east-west. Inside the aureole the metasediments are often tourmalinized and in some areas are highly argillised. On the western part of the granite just north of Retrew is the hydrothermal breccia pipe at Remfry Pit. Within the aureole rocks on the northwestern flank there is evidence in the float of further hydrothermal breccias, some of which have been intersected by drilling. Large areas of alluvium have been worked for placer tin deposits from prehistory up to the early part of the 20th century at Goss Moor, Criggan Moor and Breney Common and cassiterite bearing sheeted greisen vein systems are exposed in some of the pits. Uranium ores have been mined between Terras and St Stephen.



Megacrystic biotite granite

Lithium mica granite

Kaolinized granite

Mineralization

Sheeted greisen vein tin deposits occur within the mass, mainly centred near Hensbarrow. The larger veins were worked by underground mining. Tourmaline veins crosscut the pits which are also staniferous and occasional carry 'wood' tin. Wood tin is cassiterite with the appearance of having rings like a tree and is indicative of high-level tin mineralization. Within the aureole rocks to the north, where the granite lies at a shallow depth, there are a variety of tin mineralization styles. These range from stanniferous tourmalinite breccias, stockworks, microsills and replacements. Calc-silicates and rhyolites in the area have in some instances acted as chemical and/or structural traps. Calc-silicates, due to their more brittle nature than the surroundings meta-sediments, have been extensively fractured during tectonism and as a consequence these have provided conduits for ascending mineralizing fluids. Fracturing has also occurred in the rhyolites. Due the mineralogical composition of the calcsilicates they are more chemically reactive than the surrounding rocks and wall rock reaction with ascending mineralized fluids can result in the deposition of tin in the form of cassiterite.



Tourmaline-quartz veins







Wood' tin

The best observed example of hydrothermal brecciation occurs at Wheal Remfry where a build up of pressure below a solid carapace (roof) of the granite formed the tourmaline-rich breccias. Here boron-rich fluids accumulated. When the pressure of these fluids exceeded the weight of the rock above, known as the lithostatic load, the fluid escaped in vertical ascending fractures and in doing so turned into a gaseous state. On reaching the surface the pressure suddenly dropped leading to explosive decompression producing sidewall spalling due to a release of pressure on the rock around the vent. If the event was pulsed it produced rock flour due the 'grinding' of the rock fragments and the production in some instances of pebble breccias, these however are not seen at Wheal Remfry. The hydrothermal breccias contain not only granite fragments but also



Remfry breccia

fragments of metasediments in a mainly quartz-tourmaline-rich matrix. Near the surface sheeted tourmaline veins/stockworks surrounded the breccia pipe. In the Indian Queens area these are tin bearing.



Adapted from Halls 1994

Spailing tropps side walt Bread pipe tournalinised granite

Remfry breccia pipe

mineralization Tin in the northern flank of the St Austell controlled Granite is predominantly by north-south fracture zones. which also control the hydrothermal breccias. Where these fracture systems intersect other rock types such as the skarns and rhyolites striking east west, these are also tin mineralised, either/or acting as structural/chemical traps. These north-south fracture systems acted as conduits for ascending Sn bearing hydrothermal fluids. The mineralization is interpreted as early, near roof and tin only, as there is an absence of sulphide overprinting. The mineralization is therefore simple with only quartz +/tourmaline and locally was very enriched. mineralization Tin into pentrated the cleavage/bedding producing a striped appearance, similar to



that of the tourmalinization in the area. In the vicinity around Indian Queens there are excellent examples of this style of mineralization and the area was investigated in the early 1980s for the potential for economic deposits for exploitation.



Cassiterite from Parka Mine



Tourmalinized metapelites

The isolated stock of non-megacrystic lithium granite at Castle-an-Dinas, to the north of the main mass, cuts the wolfram bearing lode at Castle an Dinas, demonstrating that the granite here was later than the tungsten mineralization. The north south-striking lode has the appearance of greisen style mineralization. Occuring with the wolfamite and quartz are löllingite, arsenopyrite, lithium mica, rare cassiterite, native bismuth and bismuthinite. The country rocks are both argillized and tourmalinized Devonian slates. The mineralization is dated to some 285-275Ma with temperatures from 500 to 200°C, with the granite at 272Ma. It is assumed that the tungsten mineralization was associated with an earlier intrusion of granite at depth, forming in the apical region of the stock, to be later intruded by a late stage granite.



Wolframite from Castle-an-Dinas



Quartz-tourmaline Rock



Roche Rock

Quartz-tourmaline rock

Roche Rock stands out as a rocky outcrop some 20m high on the northern flank of the St Austell granite with an approximate outcrop of some 600m x 300m. The rock type is one of resistant quartz-tourmaline or intrusive tourmalinite. It is interpreted as the last phase of the intrusion when the melt was rich in boron resulting in extensive tourmalization. It may well have been coeval with the hydrothermal breccias seen on the northwestern lobe of the St Austell Granite but the fluids in this case did not reach the surface to produce explosive breccias.

Rhyolite

Rhyolite, in some cases devitrified, occur cross-cutting the granite and country rocks forming an approximate circular inpersistent ring of dykes. These postdate the phase of tourmalinization mineralization and hydrothermal breccias. Rhyolites, or as they are known in Cornwall as 'elvans', are granitoid in character and also generally predate the sheeted vein mineralization and postdate granite emplacement.





Rhyolite

Devitrified rhyolite

Kaolinization



View of china clay country

After Bristow 1996



China clay pit

The St Austell granite is the largest producer of primary kaolin in the UK. Criggan Moor, towards the eastern end of the St Austell granite, forms the eastern limit to kaolinization, which extends in 'pockets' to Retew to the west. Kaolinization was the result of initial hydrothermal activity in the Permian to be followed much later during the Palaeogene by deep chemical weathering. Hydrothermal activity probably prepared the granite in providing conduits for meteoric water to penetrate deep into the mass. During this deep penetration the feldspars were altered to kaolinite and any earlier clays such as smectite were converted to kaolin. Deep weathering also altered the micas, with the fluids becoming rich in iron from the alteration of the biotite, and uranium from leaching the uraninite from the granite. These draw-down centres for the meteoric water produced funnel shaped kaolin deposits. These kaolinized pipes extend down to depth of 250 m. During kaolinisation up to 25% of the weight of the granite is lost. Temperatures for producing kaolinization vary from 70 to 150°C. On penetrating further the fluids were heated by radiogenic activity and a circulation or convective cell was created. The fluids in the convective cell, exploiting fault zones, probably reached the surface as hot springs depositing their iron and uranium as the pressure and temperature decreased.

Pegmatites



Tresayes pegmatite outcrop



Pegmatite

Comb-layer pegmatites or stockscheider occasionally occur at contacts between granites and other pegmatites occur near the contact between the granite and country rocks. One of the most important is the Tresayes pegmatite; this is exposed just south of Roche Rock near the northern granite-country rock contact close to Hensbarrow. The rock was originally mined for feldspar for the glass industry. Volatiles that had accumulated during the intrusion of the granite and slow cooling produced large crystal masses of predominantly quartz and feldspar. These are the last species to crystallize and become concentrated in small water-rich pockets or veins and include H_2O , CO_2 , Nb, Ta, Sn, B, Li, F, and Be. Under the large overburden pressure, the pockets cool extremely slowly, forming large crystals in the vapour pockets.

Placers

Placer cassiterite has been worked extensively since prehistory in the St Austell area. One of the largest areas worked was the Goss Moor covering an area of some 400 ha. The deposits were formed at the end of the Devensian some 10,000 years BP when periglacial conditions produced stanniferous 'head' deposits. These also incorporated resistates such as cassiterite left on Tertiary Age peneplanation surfaces. These were then winnowed by fluvial action as the climate ameliorated to form basal enriched tin placers in low-lying areas.



Helman Tor

View from Helman Tor towards Breney Common

To the east of the area lies Helman Tor, an isolated granite hill projecting out of the low-lying area surrounding it. Just west of the Tor lies Breney Common, an area worked extensively for placer cassiterite from prehistory up to the early part of the 20th century.

Uranium and iron mineralization



Chimney at South Terras Mine

Torbernite



Adapted from C. Smale 1990

The St Austell granite is surrounded by mainly Fe mineralization in north-south fracture zones and occasionally these are also highly uraniferous such as at the South Terras Mine to the southwest of the main St Austell granite mass. South Terras is the only mine in the Cornubian Ore Province to have been worked exclusively for uranium. Initially the lode was worked for iron ores and only with depth were major uranium ores discovered with the Uranium Lode over 500m in length. It is assumed that the uranium has been derived from the St Austell granite during the process of kaolinization when iron was leach from biotite micas and uranium from uraninite in the granite. The primary ore of uranium worked at South Terras was uraninite or pitchblende, a variable oxide of uranium. A secondary zone of supergene enrichment occurred in the upper levels of the mine characterised by torbernite and autunite, hydrated phosphates of copper/uranium and calcium/uranium respectively. The primary mineralization phase at South Terras is considered to have occurred approximately 225 Ma, followed by remobilisation and partial loss of radiogenic lead as recent as 60 Ma. Nickel and cobalt have also been recorded from the mine as well as bismuth. The mine commenced uranium extraction in the late 1800s and ceased in the early part of the 20th century; the area was however reinvestigated in the 1950s by the UK Atomic Energy department.