The geology, mineralisation and mineral potential of Cornwall and Devon

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Simplified bedrock geology

Published 1:50,000 geological maps of highlighted areas not based on 'recent' resurvey

So what's the big picture (in 6 minutes)?

Geology of SW England south of the Bristol Channel: Bray Fault (BCBF) is more closely related to that of mainland Europe shown in yellow.
Contrasting onshore and offshore geology
SW England principal geological events

- **Closing oceans and creating mountains**
- **Collapsing mountains**
- **Basins and brines (Rifting 1)**
- **Mind the gap (Rifting 2)**
- **Atlantic margins**
- **In the vice**

**Tectonics**
- Rheic Ocean margin
- Pangea intraplate
- Atlantic margin / European intraplate

**Felsic seds & rocks**
- Cu-Pb-Zn ± Au
- W-Sn-Cu Zn-As + others
- Pb-Ag Zn-Ba + others; U-remob.
- granite-related
- cross-course
- hydro-carbons; U-remob.

**Mafic seds & rocks**
- dolerite
- sz
- SLFZ

**Metals & rocks**
- ball clays
- Supergene / placers

**Events**
- Hot and cold
- Onshore
- Offshore N+S
- Onshore E

**Time periods**
- Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Palaeog’, Neog’, Quat’

**Geological markers**
- 400, 300, 200, 100, 23, 2.6, 0 million years
- Wealden, Bovey, Chalk, Lundy, St Erth, Wolf / Epson, SLFZ

**Geological processes**
- Extensional
- Strike-slip
- Thrust
(1) Closing oceans / creating mountains

Azor et al. (2008, Tectonics)
Prograde metamorphism of lower crust during / following Variscan convergence. High T metamorphic fluids along NW-SE strike-slip fault zones.

Lithospheric extension brings about mantle partial melting and injection of melts into already hot lower crust.
Post-Variscan mineralisation, china clay and hydrocarbon occurrences

Principal metals
- Significant W mineralization
- Pb-Ag ± Zn mineralization dominant
- Cu mineralization dominant
- Sn mineralization dominant

Minor metals
- U-Bi-Co-As-Pb
- Ni-Co-Ag-As-Bi

China clay
- Principal occurrences

Hydrocarbons
- Principal seeps in mines

Sources: Dines (1956); Parnell (1988), Jackson et al. (1989)
Margin of Great Cross-course fault zone, deep adit level, South Crofty Mine
(4) Basins and brines (rifting 1)

- Fluids in P-T hosted veins in offshore similar to cross-course
- Some cross-course fluids in E-W veins with earlier granite fluids
- Some cross-course quartz (Menheniot) has granite-type fluids

Source: Gleeson et al. (2001, GCA)

Source: Scrivener et al. (1994) JGSL
(4) Mind the gap - where's the Jurassic?

Cretaceous Upper Greensand unconformably overlying Triassic Mercia Mudstone Group east of Sidmouth (viewed from Chit Rocks)
Potential link with kaolinisation?

St Agnes Formation, Cornwall
Neogene (Miocene)

(5/6) Atlantic margin / In the vice

SUPERGENE ZONE

GOSSAN
(CASSITERITE, QUARTZ, IRON OXIDES).

ZONE OF COPPER OXYSALTS, OXIDES AND NATIVE METAL

ZONE OF SECONDARY SULPHIDES (CHALCOCITE, ETC)

ZONE OF PRIMARY SULPHIDES (CHALCOPYRITE, ETC)

ZONE OF MIXED Sn/Cu ORES

ZONE OF CASSITERITE

QUARTZ - TOURMALINE 'ROOTS' OF LODE SYSTEM

TIN ZONE
(WORKED AT DOLCOATH)

PRESENT SURFACE

PRESENT WATER TABLE

MESOZOIC WATER TABLE

SO - CALLED COPPER ZONE

SO - CALLED TIN ZONE
(BUT TIN IN WORKABLE CONCENTRATIONS MAY OCCUR UP TO THE SURFACE).

DOLCOATH MAIN LODE - TIN ZONE UNBOTTOMED (BUT APPROACHED) AT 550 FATHOMS.
Cold and hot alluvial cassiterite

Camm and Hosking (1985)
Commodities in SW England

- Metallics- Sn, W, (Cu, Zn, U, Au?)
- China Clay (By-products Li, Nb, Ta)
- Ball Clay
- Aggregates
- Building Stone
- Holes (Waste Disposal)
## Fracture-controlled mineralization

<table>
<thead>
<tr>
<th>Type</th>
<th>Metals</th>
<th>Gangue</th>
<th>Fluids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-course veins</td>
<td>Pb, Zn, Ag, Fe, Sb, U</td>
<td>qtz, bar, dol, cal, fluor</td>
<td>Fluids from sedimentary basins</td>
</tr>
<tr>
<td>Chlorite-tourmaline veins</td>
<td>Sn, Cu, Pb, Zn, As, Fe</td>
<td>qtz, kspar, chl, tour, hem, fluor</td>
<td>Variable mixing of granite and country rock fluids</td>
</tr>
<tr>
<td>Tourmaline-quartz (breccia) veins</td>
<td>Sn</td>
<td>tour, qtz</td>
<td></td>
</tr>
<tr>
<td>Skarn/ replacement</td>
<td>Sn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greisen-bordered sheeted veins</td>
<td>W, As, Sn</td>
<td>qtz, musc, tour</td>
<td>Granite-derived fluids dominate</td>
</tr>
<tr>
<td>Pegmatites</td>
<td>W, As, Bi, Mo, Sn</td>
<td>qtz, kspar, musc, tour</td>
<td></td>
</tr>
</tbody>
</table>

**After Chesley et al. (1993)**
Tin Price

Source: MSC's annual report 2010
Underground Mining
Hemerdon project – Well drilled and geological simple

- Drill location plan
- Section showing Geology
- Potential to yield Long mine life
- Amax pilot plant recovery ~70%

Heavy Media Separation, gravity.
Mineral Rights Issues

- Locating owners
- Owner’s liabilities
- Owner’s reputation
- Dues
- Length
- LEGAL COSTS
St Austell China Clay Area
TellusSW Data for Minerals
an explorer’s view

• **Magnetics**
  Better delineation of lithologies and feeder or major faults at surface and depth
  Detection of magnetite and pyrrhotite rich units

• **Radiometrics**
  Direct detection of uranium \(^{214}\text{Bi}\) anomalies and mapping granites or sediments (ternary plots)

• **Lidar**
  Mapping topography for detection of old workings and lithology

• **Hyperspectral**
  Mineral mapping
Antimony Spatial Context
Tamar Catchment

Rawlins, O'Donnell, 