AN OVERVIEW OF SN-W METALLOGENY IN NORTH EAST QUEENSLAND

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INTRODUCTION

Tin (- tungsten) mineralisation in north-east Queensland was discovered in the 1880's and, since then, there has been intermittent exploration and mining of both hard rock and alluvial resources. The north-east of Queensland is characterised by a large number (many hundreds) of Sn and W deposits, indicating geological conditions favourable for Sn-W-Mo mineralisation. While the deposits are generally small, the area has been one of Australia's major sources of Sn and W.

Most of the Sn-W mineralised districts in north-east Queensland, and the largest known deposits, are located in the Siluro-Devonian Mossman Orogen in the east. To the south, the relatively small Sn deposits of the Kangaroo Hills district straddle the boundary between the Mossman and the Neoproterozoic–Ordovician Thomson Orogen. In the west, scattered Sn and W deposits occur within the Paleoproterozoic–Mesoproterozoic Etheridge Province of the North Australian Craton (Figure 1), with the at least the larger ones of placer type.

The North Australian Craton and the Thompson and Mossman Orogens were intruded by Carboniferous–Permian plutons of the extensive Kennedy Igneous Association (KIA), and covered by roughly coeval volcanic rocks (Figure 1). The KIA mainly comprises I-type magmatic rocks, with local S-type intrusions to the north-east of a NW trending line that passes through Atherton and Innisfail, and minor scattered A-type rocks south-west of the Atherton-Innisfail line. The Sn-W mineralisation of north-east Queensland is closely associated with these Carboniferous-Permian igneous rocks of the KIA.

DEPOSIT CLASSIFICATION

The Sn-W-Mo deposits of north-east Queensland have different metal associations and can be classified as W-dominant, W-Mo-Bi deposits, and Sn-dominant deposits (Table 1). These subgroups have characteristic features and time-space distributions.

W-dominant deposits

These are represented by the Mt Carbine and Watershed deposits north-west of Cairns. Both deposits are hosted in siliclastic rocks and mineralisation occurs mainly in sheeted quartz +/- feldspar +/- muscovite veins, with local disseminated mineralisation at Watershed. Tungsten mineralisation at Mt Carbine is dominantly wolframite with minor later scheelite, while at Watershed scheelite is the only tungsten ore mineral.

Wall rock alteration around veins at Mt Carbine is mainly chlorite-illite, whereas wallrock alteration at Watershed comprises skarn assemblages (including garnet, pyroxene, clinozoisite and amphiboles).

Mineralisation in the Mt Carbine - Watershed area has been dated at 287 - 253 Ma (this project; Higgins et al., 1987).

Figure 1. Geology of north-east Queensland and the distribution of W and Sn deposits. (GDA94, UTM Zone 55).

W-Mo-Bi deposits
This group of deposits occurs mainly in the NNE-trending Wolfram Camp - Bamford Hill corridor, and is represented by the Wolfram Camp and Bamford Hill deposits. The characteristic features of this group are:

Mineralisation is confined to granitic intrusions.

Ore occurs in pipe-like bodies and discontinuous pockets of quartz +/- minor calcite, which grade outwards to quartz-rich greisen. The pipes and pockets are located in the roof zone and upper side margins of plutons, and oriented parallel to intrusion margins.

The main W mineral is wolframite, with minor scheelite replacing wolframite. Molybdenite is the main Mo mineral, locally occurring intergrown with wolframite. Minor cassiterite, bismuthinite and native bismuth post-date the wolframite.

Most alteration ore minerals are coarse- to very coarse-grained (wolframite crystals can be up to 50 cm long).

Molybdenite from both Wolfram Camp and Bamford Hill has been dated at 308 - 306 Ma.

Sn-dominant deposits
Deposits with Sn as the dominant economic metal cluster in the Collingwood, Herberton and Kangaroo Hills districts (Figure 1). The deposits can be subdivided into two groups based on host rocks, and further subdivided based on alteration assemblages and distribution.

Group 1 deposits are hosted in metasedimentary rocks whereas **Group 2** deposits are in fractionated microgranites and/or in coarse-grained batholithic granite adjacent to microgranites. Variations in alteration allow the two groups to be subdivided into the following sub-types:

1A Mineralisation hosted in carbonate wall rocks resulting in skarn alteration assemblages. The typical ore assemblage is cassiterite - magnetite - fluorite - wollastonite - pyroxene. The skarn Sn deposits are typically larger than other sub-types in north-east Queensland.

1B Mineralisation hosted in metabasalts with skarn alteration assemblages dominated by pyroxene or massive chlorite. The ore assemblage is typically cassiterite-magnetite.

1C Mineralisation occurring at the boundary between metabasalt and chert. Cassiterite occurrs in cordierite-cummingtonite rocks that have been altered to chlorite.

1D Mineralisation hosted in siliclastic metasedimentary rocks. Ore types include quartz-tourmaline-cassiterite veins and breccia pipes, chlorite- and/or quartz-cassiterite pipes and veins with chlorite haloes, and quartz-cassiterite veins with silicification haloes.

1E Hydrothermal breccias located in metasedimentary rocks and porphyry dykes, and transitioning to cassiterite-bearing chlorite lodes at shallower levels.

2A Feldspathic alteration: albite-altered lenses with disseminated cassiterite, and locally with quartz - fluorite - cassiterite +/- K-feldspar veinlets and veins.

2B White mica greisen: pipes and veins of quartz-cassiterite (+/- muscovite, wolframite, fluorite, topaz, sulphides) with haloes of fine-grained white mica +/- quartz.

Table 1. Major W and Sn deposits in north-east Queensland.

Tungsten Deposits	**Metal Association**	**Deposit Style**		**Resources (Mt)**	**Grade WO_3 (%)**	**Production WO_3 (t)**	**Total WO_3 (t)**
Mt Carbine	W-dominant (wolframite, scheelite)	Steeply dipping veins, largely hosted in siltstone - shale		59.3[b]	0.12[b]	12,546[c]	83,706
Watershed	W-dominant (scheelite)	Sheeted veins and disseminations, largely hosted in skarn altered sediments		49.2[a]	0.14[a]		70,400
Wolfram Camp - Bamford Hill	W-Mo-Bi dominant (wolframite, minor scheelite, molybdenite; bismuthinite, native bismuth)	Quartz pipes and pockets in the roof zones and margins of plutons		2.393[d]	0.29[d]	5,253[c]	12,260
Tin Deposits	**Metal Association**	**Deposit Style**	**Sub-Type**	**Resources (Mt)**	**Grade Sn (%)**	**Production Sn (t)**	**Total Sn (t)**
Pinnacles	Sn-dominant (+/- base metals)	Skarn: wrigglite with cassiterite-bearing magnetite bands is common	1A	7.035[e]	0.30[e]		21,105
Gillian	Sn-dominant (+/- base metals)	Skarn: wrigglite with cassiterite-bearing magnetite bands is common	1A	2.53[e]	0.78[e]		19,734
Collingwood	Sn-dominant	Sheeted quartz-tourmaline and greisen veins in granite	2B	0.643[c]	1.19[c]	5,133[c]	12,793
Great Nthn Gully[c] Great Nthn East[c] Great Sthn Tin[c]	Sn-dominant	Veins and pipes in granitic rocks.	2B	Combined figures for three adjacent deposits			11,903
Tommy Burns[+]	Sn-dominant (wolframite, scheelite +/- base metals)	Steeply dipping pipes in altered sandstone	1C			11,520[c]	11,520
Vulcan	Sn-dominant (+/- base metals)	Pipes in siliclastic metasedimentary rocks	1D			10,993[c]	10,993
Jeannie River	Sn-dominant (+/- base metals)	Veins in sheared sediments[i]	1D	2.24[f]	0.47[f]		10,583
Sailor Tin	Sn-dominant	Sub-horizontal lenticular bodies of greisen in granite[i]	2B	10[g]	0.08[g]		7,874
Station Creek	Sn-dominant (+ wolframite)	Placer		46 M m^3[c]	180 g/m^3[c]		6,520
Tate River	Sn-dominant	Placer		9.76 M m^3[c]	587 g/m^3[c]	1,256[c] alluvium	6,154
Mount Holmes	Sn-dominant (+ scheelite, wolframite, bismuthinite)	Quartz-feldspar and pegmatite veins in chert[i]	1D	10[c]	0.055[c]	142[c]	5,654
Baal Gammon*	Sn-dominant (+/- base metals)	Veins and breccia pipe	1E	2.8[h]	0.20[h]		5,600
Windermere	Sn-dominant (+/- base metals)	Skarn: massive magnetite-hematite[i]	1A	2.04[e]	0.27[e]		5,508

2C Chlorite alteration: pipes and veins of quartz-cassiterite (+/- wolframite, fluorite, topaz, sulphides) with haloes of intense chlorite alteration.

It has been speculated that the various alteration and mineralisation types listed above are related, with the pipe and vein-style mineralisation hosted in metasediments extending to lodes in granitic intrusions at depth. The associated alteration assemblages in the metasediments would transition from silicification, to chlorite, to tourmaline with depth, and to white mica greisens and feldspathic alteration in the granitic intrusions.

AGE OF MINERALISATION

The age of Sn-dominant mineralisation varies from district to district, with the earliest Sn mineralisation occurring in the Kangaroo Hills district (345-339 Ma), and younger Sn mineralisation in the Herberton-Emuford-Mt Garnet district (327-317 Ma). W-Mo-Bi deposits in a north-south corridor west of the Herberton Sn field formed at 308-306 Ma.

Age dates from the W-dominant mineralisation in the Mt Carbine - Watershed area north of the Herberton District are in the range 287-253 Ma, and may be broadly synchronous with the Collingwood Sn mineralisation further north where the mineralisation age should be younger than ~276 Ma, the age of the host granite, although accurate mineralisation ages for the Collingwood district are yet to be obtained.

PROSPECTIVITY

The setting and style of Sn-W-Mo mineralisation in north-east Queensland suggests that:

Carbonate rocks are the most favourable host rocks for forming larger deposits.

In siliclastic wall rocks, extensive chlorite alteration seems to indicate higher grade Sn mineralisation.

In granitic wall rocks, white mica greisen is more favourable to mineralisation than topaz-bearing greisen and felspathic alteration.

Mineralisation confined within intrusions may indicate the magma did not exsolve sufficient water to rupture the carapace and such deposits may have limited tonnage potential.

Previous drilling and mining operations in the north-east Queensland Sn-W-Mo districts have generally been fairly shallow. Elsewhere in the world, vein-type W mineralisation may transition to skarn or massive greisen-related mineralisation at depth (e.g. southern Jiangxi, China - see Xu, 2008). Consequently, in north-east Queensland the potential for mineralisation at depth is considerable, and Sn and W vein and breccia style mineralisation hosted in wall rocks should be priorities in future exploration.

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