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A CLASSIFICATION OF TIN PROVINCES *

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INTRODUCTION

The problem of classifiying ore deposits has exercised the minds of several generations of geologists, and although the state of the art is far form perfection, considerable advances have occurred during the last decade. The underlying premise of the exercise is that correct groupings of related deposits will ultimately give valuable indications regarding genesis. Increasing attention has recently been given to the need to incorporate environmental factors into the classification, as well as the details of the actual deposit.

Early concepts from the U.S.S.R. stressed classification based primarily upon mineralogical characteristics, i.e. tin bearing pegmatites, quartz cassiterite, quartz sulphide, etc. This however proved unworkable and more recently ITSIKSON (1960) has approached the problem from an environmental viewpoint, relating tin deposits to different types of batholithic regions produced at different stages in the development of fold belts, this style of approach seems to offer a sound basis for further development. A simplified version of the Itsikson approach is given by ŠTEMPROK (1969), reproduced here as Table I.

The Itsikson approach was adopted by TAYLOR (1974) who similarly stressed that detailed analysis of provinces might provide a basis for classification and genetic interpretation of tin deposits.

In recent years the author has been collecting and synthesizing data concerning the 40-50 known tin provinces, with a view to classification. Whilst it is inappropriate to detail the characteristics of individual provinces here, it does seem that most provinces can be accommodated within a modified version of the Itsikson approach. Many provinces have not been well investigated or documented and in this sense the classification presented below is regarded as provisional and subject to modification as more data becomes available. Some of the environments are illustrated by Figs. 1-4.

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TABLE I

Classification of tin-bearing formation modified according to M. I. ITSIKSON (From ŠTEMPROK, 1969)

Regions of tectonic and magmatic reactivisation		
Magmatic formation	Tin-bearing formations	Metallic associations of Sn
Subaerial effusions and extrusion of rhyolites	Volcanic group rhyolitic formations	In
Near-surface small intrusions associated with effusive acid or intermediate	Subvolcanic group (casiterite-silicate, cassiterite-sulphide formations tin bearing skarns)	Ag, As, B, F, Pb, Sb, Zn
Mobile zones		
Late		
Hypabyssal intrusions of composition associated with acid members	Hypabyssal group (cassiterite-silicate, cassiterite-quartz formations)	Ag, As, Au, Bi, Co, Cu, Pb, Zn, W
Middle		
Batholithic intrusions of acid and ultra-acid granite and their satellites	Subabyssal (batholithic group) cassiterite-quartz-formations tin-bearing skarns tin-bearing pegmatites	As, B, Be, Bi, Cs, Li, Mo, Nb, Rb, Sn, Ta, W

ENVIRONMENTS CONTAINING SIGNIFICANT PRIMARY CONCENTRATIONS OF TIN (*1 See footnotes)

General Environment (1)

Tin deposits associated with granitoids which show a close spatial and temporal relationship with a major period of orogeny, i.e. folding, fracturing, and uplift. Granitoid emplacement predominantly post major folding, i.e. late stage and controlled by major fracture-suture zones. Designated: FOLD BELT TYPE.

Subdivision (a)

Tin concentrations associated predominantly with extrusives and pyroclastics. Minor related intrusives.

Form of associated igneous rocks.

Terrestrial lava flows, tuffs, volcanic breccias. Minor stocksdykes and intrusive sheets with volcanic, non porphyritic to minor porphyritic, textures.

Composition of associated igneous rocks.

Predominately rhyolites with andesites, dacites, and latites.

Economic significance.

Primary ores: Very minor. Secondary ores: Very minor.

Examples.

Mexico (Fig. 1).

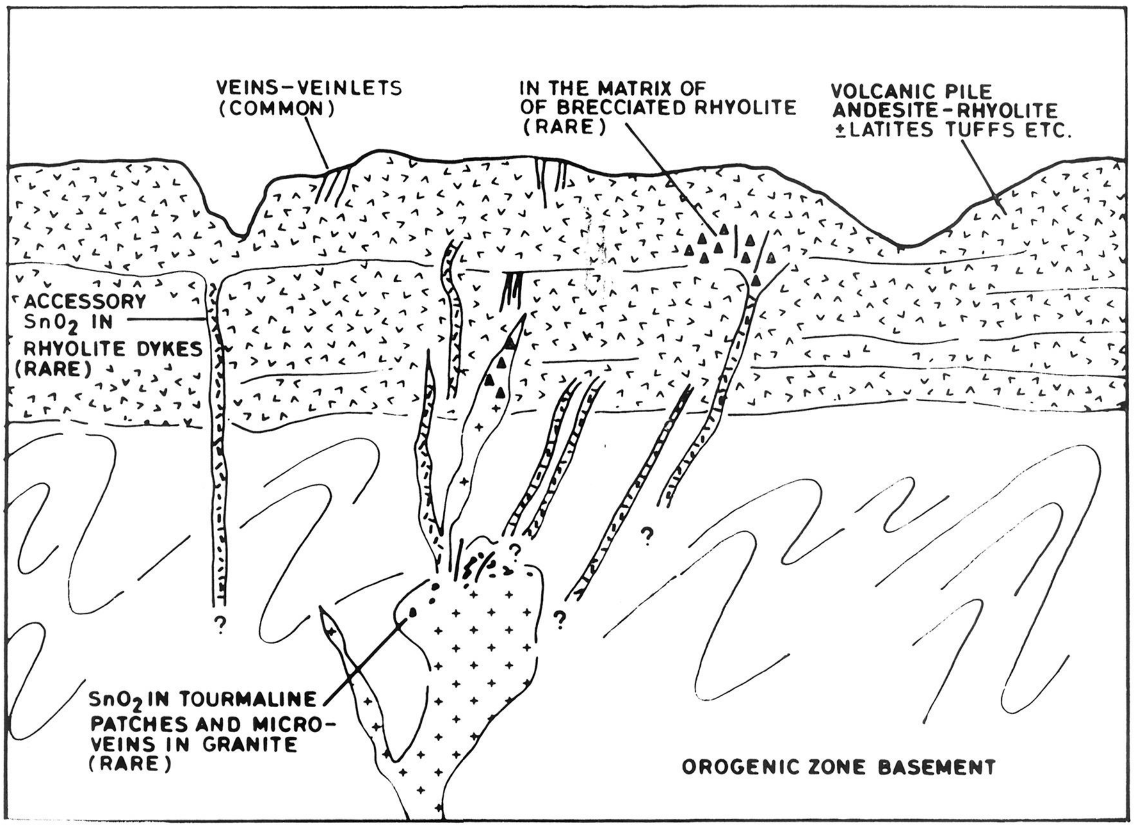

FIG. 1

Diagram to illustrate the main features of the Mexican style volcanic tin province (Type 1a)

Subdivision (b)

Tin concentrations associated with intrusive complexes of subvolcanic nature occurring in association with terrestrial extrusives.

Form of associated igneous rocks.

Small stocks, pipes, and irregularly shaped intrusives. Often steep walled and funnel shaped at depth. Associated dykes, dyke swarms, sills, breccia pipes, etc.

Composition of associated igneous rocks.

Diverse composition with porphyritic textures predominate. Granite porphyry, quartz porphyry, dacite, quartz latite porphyry, quartz diorite, granodiorite, granite, etc. Aplites and pegmatites are very rare. Volcanics are predominantly rhyolites and andesites.

Economic significance.

Primary ores: Major to minor. Secondary: Minor.

Examples.

Bolivia (Southern portion).
Southern Maritime Territory, U.S.S.R.
Japan.
Maly Kinghan, U.S.S.R.
Mio Chang, U.S.S.R.

Subdivision (c)

Tin concentrations associated with intrusive complexes of mixed character, i.e. representing a deep volcanic to high plutonic environment. Extrusive rocks mostly absent, but may be present in places.

Form of associated igneous rocks.

Wide diversity in form ranging from small stocks to large scale intrusive complexes. Major massifs-batholiths are often very complex and contain a large number of intrusive phases. Active repeated intrusion prevails over a more passive environment. At upper levels garlands or rosary chains of small granitoids associated with regional fractures reflect the deeper batholith structures. Geochemically specialised granitoids are often present and may form clear end members of a granodiorite-granite differentiation sequence. Dykes, and swarms are normally abundant, although often irregularly distributed. Aplites and pegmatites uncommon.

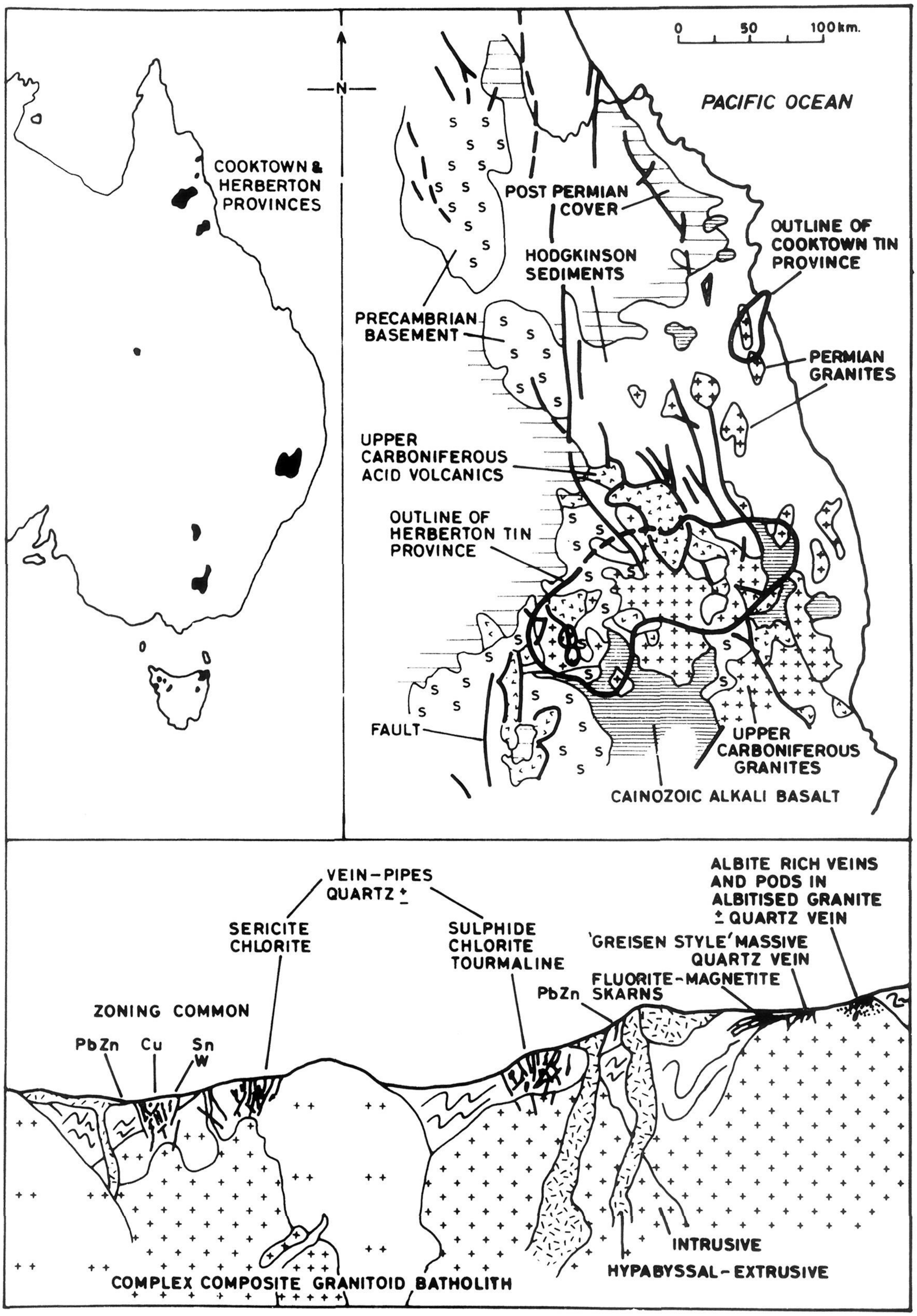

FIG. 2

Diagram to illustrate the features of the deep subvolcanic style province (Type 1c). Herberton Province, Queensland Australia

Composition of associated igneous rocks.

Diverse composition, granites and granodiorites prevail with minor monzonites, diorites, etc. Evidence of hybridism occurs in some provinces resulting in «diorites», andesine granites, etc. Hybridism is however rare. Plutonic textures prevail over porphyritic.

Economic significance.

Primary ores: Major to minor. Secondary: Intermediate to minor.

Examples.

Herberton, Australia (Fig. 2).
Kangaroo Hills, Australia.
Chukotka, U.S.S.R.
Yakutia, U.S.S.R.
New England, Australia.
?Northern Territory, Australia.
Transbaikal, U.S.S.R.
New Brunswick, Canada.

Subdivision (d)

Tin concentrations associated with intrusive complexes of plutonic character. Extrusives absent. Dykes and dyke swarms minor.

Form of associated igneous rocks.

Intermediate to large scale intrusive complexes. Massifs-batholiths generally contain a small number of individual plutons. Differentiation sequences are often well established between phases, and a relatively passive intrusion environment is suggested. Geochemically specialised granites are common, and often form minor phase end members of a granodiorite-granite sequence.

Composition of associated igneous rocks.

Predominately granites, granodiorites with minor alaskites, lencogranites and other specialised intrusives. Plutonic textures prevail. Aplites and pegmatites common.

Economic significance.

Primary ores: Major to minor. Secondary ores: Major to minor.

Examples.

Bolivia (Northern portion).
Erzgibirge, Czechoslovakia — G.D.R.
Cooktown, Australia.
Massif Central — Brittany, France.
Central Asia?

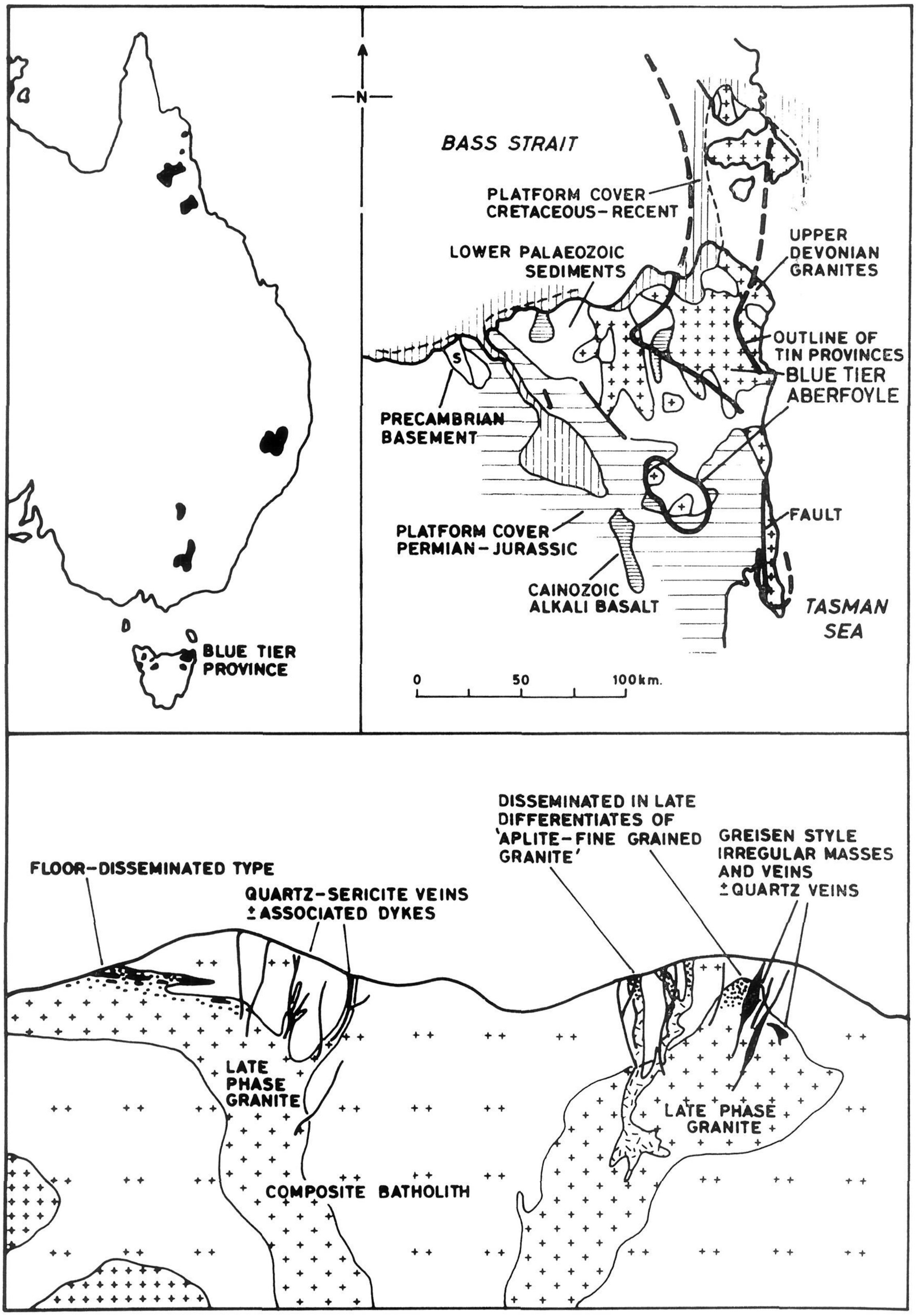

FIG. 3

Diagram to illustrate the features of the greisen style ("passive") province (Type 1d) N. E. Tasmania Province (Blue Tier) Australia

Thailand — Malaysia — Indonesia?
Ardlethan-Albury, Australia.
Seward Peninsula, Alaska.
North-East Tasmania (Fig. 3).

Note — Cornwall, England, North-West Tasmania and East Kazakstan, U.S.S.R., are difficult to catagorise and are probably 1c or transitional 1c/1d.

General Environment (2)

Tin deposits associated with granitoids emplaced via major zones of fracturing in cratonic shield areas. Granitoids are anorogenic (i.e. not locally associated with major periods of fold development. Designated: ANOROGENIC TYPE.

Form of associated igneous rocks.

Small ovate-circulate intrusive ring complexes. Minor stocks ring dykes are often capped by sheets. Minor volcanics. Groups of complexes show strong linear alignments.

Composition of associated igneous rocks.

Predominantly granite, microgranite, and rhyolite. Alkali granites present in Nigeria. Plutonic and porphyritic textures present.

Economic significance.

Primary ores: Very minor. Secondary ores: Major.

Examples.

Nigeria.
Brazil — Rondonia.
?South-west Africa.

General Environment (3)

Tin deposits associated with pegmatites in ancient metamorphic cratonic terrains. Designated: PRECAMBRIAN PEGMATITIC TYPE — Association with granitoids ranges from well established to uncertain. In many regions the geology is not well know. Subtypes may be present.

Form of associated igneous rocks.

Wide range of intrusive forms, e.g. batholiths domed complexes, stocks, sills, etc. Plutonic and gneissic textures predominate. Geology often uncertain.

Composition of associated igneous rocks.

Predominantly granites with minor alaskites. Pegmatites, aplites and granophyric phases are common.

Economic significance.

Primary ores: Minor. Secondary ores: Intermediate to minor.

Examples.

Central Africa.
Pilbara, Australia.
Greenbushes, Australia.
Broken Hill, Australia.
Brazil (Shield area).
Nigeria (Shield area) — See Fig. 4.
Southern Rhodesia.
Swaziland.
South-West Africa.
East Sayan, U.S.S.R.

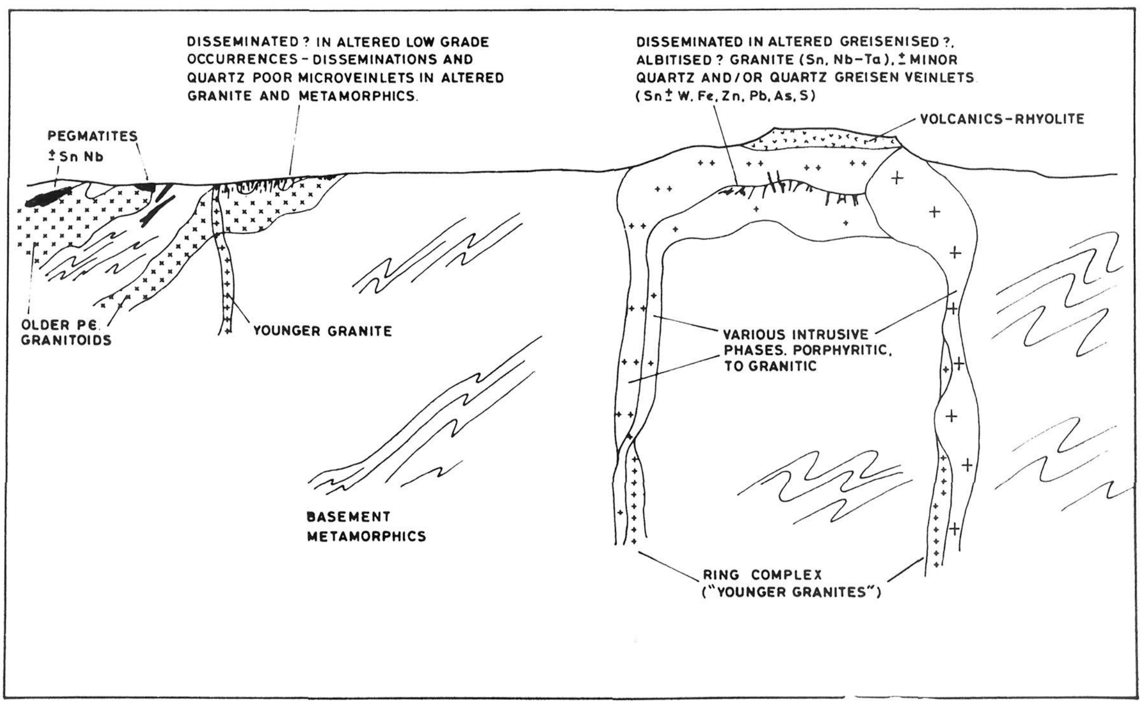

FIG. 4

General Environment (4)

Tin deposits associated with rapakivi granites in ancient metamorphic cratonic areas. Designated: PRECAMBRIAN RAPAKIVI. May also be considered as a subtype of (3).

Form of associated igneous rocks.

Massifs-stocks of polyphase granitoids. Plutonic to porphyritic textures. Late phase of massifs are geochemically specialised for tin, and associated with tin mineralisation.

Composition of associated igneous rocks.

Predominately granite with porphyritic and pegmatitic phases. Pegmatites common.

Economic significance.

Primary ores: Very Minor. Secondary ores: Very minor.

Examples.

Lodoga-Karalia, U.S.S.R.

General Environment (5)

Tin deposits associated with granitoid members of layered mafic intrusives in ancient metamorphic cratonic terrains. Designated: BUSHVELD TYPE. Unique to Bushveld Complex, South Africa.

Form of associated igneous rocks.

Stratiform granitic sheet associated with felsitic extrusions and pyroclastics. Intruded by stocks of granite, and underlain by sheets of gabbro and norite. Wide textural variation (plutonic to granophyric).

Composition of associated igneous rocks.

Predominantly granite — plutonic, porphyritic, and granophyric.

Economic significance.

Primary ores: Minor. Secondary ores: Very minor.

Examples.

Bushveld district — South Africa.

FOOTNOTES

*(1)

Significant denotes that local production centres occur with tin as a major product. Tin occurs in other environments as a minor or trace element. Whilst rarely of commercial interest the occurrences are of genetic significance, e.g. rare occurrences in association with pyritic base metal ores of probable volcanogenic origin, Sullivan — British Columbia (SWANSON & GUNNING, 1948). Timmins — Ontario (WALKER et al., 1975) Mt. Lyell — Tasmania. Trace amounts are recorded in the nickel ores of Sudbury (HAWLEY, 1962) etc.

In terms of annual world production, the following first order approximations would apply.

Group 1.	(a)	Negligible
	(b)	90-96% Mostly alluvial, (say 65-75%)
	(c)	90-96% Mostly alluvial, (say 65-75%)
	(d)	90-96% Mostly alluvial, (say 65-75%)
Group 2.	2.5%	All from alluvial sources
Group 3.	2-5%	Mostly from alluvial sources
Group 4.	Negligible	
Group 5.	Negligible	

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