1981/12. Silica in Tasmania.

T.G. Summons

Abstract

Rocks containing high concentrations of silica in Tasmania occur in both Precambrian and Palaeozoic aged assemblages of original sedimentary rocks. The most prospective Precambrian rock types are the unmetamorphosed non-turbidite type sequences located in the Rocky Cape and Weld River regions, while prospective Palaeozoic lithologies occur in the north, west, and south of the State.

The limited amount of data available on silica rich rock types in Tasmania relates to surface samples, and there is minimal information concerning the subsurface characteristics of these prospective rock types. Consequently, before any serious appraisal of the prospective rock types can be made, considerably more subsurface exploration is required.

INTRODUCTION

This report covers the known and inferred areas of rocks rich in silica (SiO_2) in Tasmania, suitable for use as sources of elemental silicon (Si) and for silicon alloys.

The chemical requirements of silica rich rocks for use in the manufacture of silicon and silicon alloys are shown in Table 1.

Table 1. CHEMICAL REQUIREMENTS OF SILICA RICH ROCKS

	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	CaO (%)	P_2O_5 (%)
Si metal	>99.0	<0.15	<0.20	<0.003	<0.01	<0.01
50% FeSi	>98.0	<0.80	<1.0	<0.02	<0.10	<0.10

The requisite physical properties of such rocks are that they are of sufficient mechanical strength (so that when crushed, the fragments occur in the size range 30-150 mm), and have good thermal stability in temperatures of up to 1000°C.

DISTRIBUTION OF SILICA RICH LITHOLOGIES

Lithologies containing high contents of silica may be broadly classified according to age into Precambrian and Palaeozoic; such rocks occur in the north, north-west, west, and south of the State.

PRECAMBRIAN LITHOLOGIES

The Precambrian in Tasmania is divided into the metamorphosed ('older') and relatively unmetamorphosed ('younger') sequences, and occurs in the Badger Head, Forth, Rocky Cape, Cradle Mountain, Cape Sorell, Prince of Wales Range, and Weld River regions (from the Structural Map of pre-Carboniferous Rocks of Tasmania, 1976). The metamorphosed Precambrian rocks consist of quartzite-schist/phyllite-amphibolite assemblages, derived from siltstone-orthoquartzite successions, and the relatively unmetamorphosed Precambrian rocks consist of either quartzwacke-siltstone-phyllite successions (turbidite sequences), or orthoquartzite-siltstone-dolomite succes-

sions (Table 2).

Table 2. PRECAMBRIAN ROCK SEQUENCES

Precambrian sequence	Type of Sequence	
	Non-turbidite	Turbidite
Unmetamorphosed	Rocky Cape (west of the Arthur Lineament), Weld River	Badger Head, Forth, Rocky Cape (east of the Arthur Lineament)
Metamorphosed	Forth, Cradle Mountain, Cape Sorell, Prince of Wales Range	--

The non-turbidite sequences are (with respect to the metamorphosed Precambrian) generally well-sorted, chemically stable, and silica rich, while the turbidite sequences (such as the Burnie and Oonah Formations in the Rocky Cape region) are poorly sorted, less chemically stable, and silica poor.

Metamorphosed Precambrian

Metamorphosed Precambrian rocks have been investigated in the Forth and Cape Sorell regions, and were found to have a variable potential for development.

(a) Forth region

Several prospects are known in the Forth region, of which the following three are probably the most significant; the Leven (on the River Leven), Dunhams (near Forth), and Wivenhoe (near Burnie). The Leven prospect consists of a friable quartz sand with quartzite nodules at the surface, and probably overlies quartzite at depth (Burns, 1965); an average analysis of this surface material is 98.7% SiO_2, 0.70% Al_2O_3, 0.02% Fe_2O_3, and indicated reserves have been assessed at 25 000 tonnes. Dunhams prospect, which is located in the Forth Quartzite, is believed to be similar to other prospects in the area as discussed subsequently; quartzite from this prospect was used in the manufacture of ferrosilicon at Newcastle during the period 1939-45, and indicated reserves have been assessed at 850 000 tonnes. The Wivenhoe prospect is similar to the Leven prospect, and Hughes (1959) estimated indicated reserves of 20 000 tonnes of high grade silica.

All three prospects require definitive investigation in the form of drilling to enable fresh rock reserves to be determined, although the following discussion of the Broken Hill Proprietary Co. Ltd work east of Dunhams prospect may be regarded as representative of their subsurface characteristics.

The BHP Co. Ltd (1977) investigated the Ulverstone and Forth Quartzites, and found them to be generally schistose and micaceous. Minor high grade quartzite (<6 m thick) was located, but most of it was shown to be due to the alteration of micaceous quartzite, from which the mica had been leached, and variably replaced with secondary silica. The depth of weathering extends from 6-12 m below the surface. Two diamond drill holes in the Forth Quartzite encountered a six metre thick zone of non-micaceous quartzite which averaged 99.10% SiO_2, 0.04% Al_2O_3, 0.42% Fe_2O_3

and 0.02% TiO_2. The Ulverstone and Forth Quartzites appear to have a limited potential for development of a large tonneage, low alumina silica mining operation.

(b) Cape Sorell region

Comalco Ltd (A.H. White, pers. comm.) investigated the Cape Sorell region on the west coast, and found that the best grades of silica were obtained from the massive orthoquartzite, while the cross-bedded and finely laminated orthoquartzite displayed inferior chemical and physical properties due to the interlayered phyllite. The average composition of the high grade orthoquartzite is approximately 99.40% SiO_2, 0.35% Al_2O_3, 0.03% Fe_2O_3, 0.001% Cr_2O_3, 0.03% TiO_2, 0.11% P_2O_5, 0.02% MgO, 0.01% CaO, 0.01% Na_2O, with 0.15% loss on ignition. Comalco observed that only the massively bedded quartzite retained its grade of SiO_2 with increasing depth, and that the finely laminated quartzite had been leached of its deleterious components at the surface, thus creating a false impression of high grade silica. The Cape Sorell area requires considerably more work to be done on it before its potential can be fully assessed, and Comalco currently hold four mineral leases in the area.

Relatively unmetamorphosed Precambrian

Rocks of this description have been investigated in the Rocky Cape and Weld River regions, with encouraging results.

(a) Rocky Cape region

The Australia and New Zealand Exploration Co. (ANZECO) explored the Rocky Cape region in the Marrawah and Nelson River districts (Brandt, 1973; 1974). In the Marrawah district, east of West Point, a massive (600 m thick), medium-grained, orthoquartzite was located, which is a probable correlate of the Bryant Hill Formation to the south-east. Chip samples taken from this orthoquartzite average 98.9% SiO_2, 0.55% Al_2O_3, 0.11% Fe_2O_3, 0.03% TiO_2, 0.004% P_2O_5, 0.01% CaO, 0.13% K_2O, with 0.18% loss on ignition. Detailed chip sampling within the area represented by the above analyses indicated the following average composition: 99.14% SiO_2, 0.43% Al_2O_3, with 0.20% loss on ignition.

ANZECO considered the potential tonneage in the West Point area to be $<150 \times 10^6$ tonnes (to a depth of 20 m), but added that the composition of the quartzite was not suitable for ferrosilicon production. However, the last comment is premature, because the area has not been thoroughly investigated to allow a proper assessment of its potential to be made. The area ahould be drilled to determine the degree and depth of leaching, and the nature of the fresh rock.

ANZECO also explored the Nelson River area (Brandt, 1973), and located narrow (2-6 m thick) beds of quartzite in a sequence of green siltstone and slate; although these quartzites averaged 99.42% SiO_2, <0.03% Al_2O_3, 0.77% Fe_2O_3, 0.06% TiO_2, <0.001% P_2O_5, and <0.02% CaO, which is apparently suitable for ferrosilicon production, their tonneage potential (75 000 tonnes) is limited.

Mapping by Gee (1971) in the Rocky Cape-Wynyard area outlined two significant orthoquartzite units in the Rocky Cape Group; they are the Jacob Quartzite and the Detention Sub-Group, which are typically fine-grained, granular, supermature orthoquartzites. An average analysis (Comalco, 1971) of Jacob Quartzite and Detention Sub-Group is 99.33% SiO_2, 0.32% Al_2O_3, 0.03% Fe_2O_3, <0.001% Cr_2O_3, 0.03% TiO_2, 0.01% MgO, <0.01% CaO,

<0.01% Na_2O, with 0.17% loss in ignition. Gee (1971) regarded the high sphericity, good rounding, and sorting as indicating a high energy environment of deposition; both units are >1200 m thick, and occur in the Dip Range, Sisters Hills, Maynes Range, *etc.*

(b) Weld River region

The Weld River region has only been investigated in the Bernard Spur-Camels Back-Glovers Bluff inlier. The Glovers Bluff deposit occurs at the southern end of this inlier (immediately south of the Weld River), and is located 38 km by road north-west of Geeveston and 95 km by road from Electrona. It consists of vertically dipping fine-grained quartzite (orthoquartzite), with minor amounts of clay minerals and the mineral hellyerite (D.J. Hassell, pers. comm.).

Previous investigations commenced with M.C. Forster sampling the deposit (Table 3), followed by Consolidated Gold Fields Aust. Ltd (1974; 1975) who drilled four diamond and four percussion holes into the deposit.

The first diamond drill hole (GB-1) was drilled from the northern side of the deposit, and was abandoned before reaching its target. GB-3 was also abandoned after passing through a fault zone on the south side of the deposit. However, drill holes GB-2, GB-4 were successful in intersecting high grade silica, as shown in Table 3.

Table 3. ANALYSES OF SILICA SAMPLES, GLOVERS BLUFF

Sample	Analysis (%)									
	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	P_2O_5	MgO	CaO	Na_2O	K_2O	LOI
Grab (M.C. Forster)	99.3	0.05	0.25	0.03	-	0.03	0.05	-	0.02	0.33
GB-2, 7. 6-115.8 m	97.9	0.94	0.07	0.05	0.009	0.07	0.03	0.01	0.29	0.33
GB-4, 0-28.6 m	≈98.0	1.02	0.11	-	-	-	-	-	-	-

The percussion holes were drilled to depths down to 13 m, and were reported as being successful in indicating high grade silica similar to that encountered in holes GB-2, GB-4. Based on the results obtained from these drilling programmes, Consolidated Gold Fields outlined three blocks of high grade silica, as shown in Table 4.

Table 4. RESERVE BLOCK ESTIMATES, WELD RIVER

Block	Tonnes x 10^6 (to -100 m)	Grade % SiO_2	Source of data
A	3.5	>98.0	Drill holes, GB-2, GB-4
B	9.7	>98.0	Four percussion holes
C	2.2	?98.0	Geological extension of Block A
TOTAL	15.40	≈98.0	

However, two points should be made to clarify the data shown in Table 4 as follows:

(i) A block of approximately the same size as block C is assumed to exist between blocks A and B, but is not shown in the table.

(ii) Glovers Bluff is approximately 200 m above the Weld River - this elevation would allow a considerably higher tonneage to be extracted from the deposit.

The Consolidated Gold Fields (1975) report stated that thermal stability tests were carried out on selected material from split core of diamond drill hole GB-2. The results are shown in Table 5. However, such tests can only give an indication of possible behaviour under actual smelting conditions.

Table 5. RESULTS OF THERMAL STABILITY TESTS ON QUARTZITE FROM GLOVERS BLUFF

Number		+ 19.0 mm After heating %	+ 4.8 mm After tumbling %
GB-2	10.7- 15.2 m	67	97
"	15.2- 21.3 m	75	97
"	21.3- 27.4 m	47	97
"	27.4- 33.5 m	72	96
"	33.5- 39.6 m	85	97
"	39.6- 45.7 m	80	97
"	45.7- 51.8 m	78	97
"	51.8- 57.9 m	86	76
"	57.9- 64.0 m	83	97
"	64.0- 68.6 m	99	74
"	68.6- 74.7 m	90	94
"	74.7- 80.8 m	0	96
"	80.8- 86.9 m	64	93
"	86.9- 93.0 m	81	76
"	93.0- 99.1 m	90	84
"	99.1-105.2 m	86	94
"	105.2-111.2 m	96	89
"	111.2-116.4 m	54	94

A bulk sample was therefore taken from the Glovers Bluff site and the smelting performance of the quartzite and other raw materials was evaluated in a test run production of ferrosilicon at Electrona. A preliminary report on the testing by Sverre Olsen of Sintef Soutes, Troheim, Norway concludes: "The initial performance of the smelting test suggest that the quartzite should be well suitable for the production of 75% ferrosilicon". Minor problems occur more with quartzite containing excessive amounts of fines, indicating that attention would need to be given to good screening of the quartzite in any large scale project.

Most of the areas of prospective (relatively unmetamorphosed) Precambrian rocks occur in the South-west Conservation Area, with its western extremities occurring in the South-west National Park.

PALAEOZOIC LITHOLOGIES

Siliceous conglomerate, quartzose sandstone and siltstone predominantly of Ordovician age occur extensively throughout the north, west, and south of the State. These lithologies occur east of the Badger Head region

(Beaconsfield), west of the Forth, and north and west of the Cradle Mountain regions, between the Cape Sorell and Prince of Wales Range regions (Queenstown area), and north (Adamsfield-Maydena area) and south (Hastings area) of the Weld River region (refer to the Structural Map of pre-Carboniferous Rocks of Tasmania (1976) for details).

Quartz sandstone and conglomerate has been used from the Beaconsfield, Queenstown, and Hastings areas. At Beaconsfield, the Tasmanian Electro Metallurgical Co. Pty Ltd (TEMCO) are currently mining silica rich lithologies from the Cabbage Tree Formation for use in the manufacture of ferrosilicon at Bell Bay. Quartz sandstone of similar age (Silurian Crotty Sandstone) was mined near Queenstown for use as a metallurgical flux by the Mt Lyell Mining and Railway Company, and others, and the Australian Commonwealth Carbide Company Ltd used quartz sandstone from the Hogs Back deposit near Hastings for ferrosilicon production during the period 1939-45.

Generally, the Palaeozoic lithologies rich in silica have received little attention compared to the Precambrian silica rich rock types in the State.

The Hastings area has been subject to limited exploration, beginning with Hughes (1960) who chip sampled the Hogs Back and grab sampled the Caves Road deposits (Table 6), both of which he considered to be of Precambrian age.

Forster (1973) described the Hogs Back, South Hogs Back, South Lune River and Caves Road deposits from which he took grab samples, obtained after costeaning (Table 6).

Table 6. HASTINGS AREA SILICA DEPOSITS

Deposit	Analyses of chip/grab samples (%)					
	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	MgO	CaO
Hogs Back) South Hogs Back) South Lune River)	99.45	0.27	0.12	0.06	0.02	0.02
Caves Road	99.2	-	0.14	-	-	-

Consolidated Gold Fields are reported to have put two diamond drill holes into the Hogs Back deposit during 1972-74, but no details (logs, analyses etc.) are currently available; it is believed C.G.F.A. lost interest in this deposit because of its small tonneage potential, and apparently did not pursue their investigations with regard to analyses of the core from the drill holes.

Recent work in the area has indicated the Caves Road deposit to be a type of lag deposit composed of spongy boxwork silica, which appears to have been derived from the silicification of either dolomite or limestone underlying the deposit.

Sharples (1979) assigned an Ordovician age (based on fossil evidence) to the other three deposits shown in Table 6, and using this evidence, it is possible to predict the location of other quartzose sandstone occurrences in the area, stratigraphically below the Ordovician Gordon limestone.

Insufficient data precludes any estimation of size for the Hogs

Back-South Hogs Back-South Lune River trend, and the area warrants further exploration.

The areas of Ordovician quartzose sedimentary rocks range in status from inclusion in the South-west Conservation Area (most of the Adamsfield-Maydena area), to Crown/Leasehold Land (Hastings and part of Adamsfield-Maydena area).

GENERAL COMMENTS

Both the Precambrian and Palaeozoic lithologies with high silica contents have a common characteristic - that of generally unknown depths of leaching with consequent near surface natural benefication.

Most of the analyses of quartzite quoted in this report relate to surface samples, and the porosity common to most samples is considered to be due to the removal of impurities in solution (*e.g.* white mica) during weathering.

As the economic viability of any future mining operation in a given silica deposit will depend, in part, not only on the dimensions, but the physical and chemical properties of the leached zones, it becomes imperative for subsurface data to be obtained in any serious appraisal of a silica deposit. This type of information is most readily derived by drilling, and preferably diamond drilling.

CONCLUSIONS

1. It appears that despite the similar orthoquartzite dominant nature of the non-turbidite sequences (Table 2), the relatively unmetamorphosed Precambrian lithologies have the greatest potential for large tonneage, high silica (low Al_2O_3 *etc.*) deposits.

2. The supermature orthoquartzite of the Jacob Quartzite and the Detention Sub-Group (both in the Rocky Cape Group), and their correlates elsewhere in the State, represent prime exploration targets for the location of high grade silica deposits. The Bryant Hill Quartzite and its correlates, although less thoroughly evaluated for their silica potential, should also be subjected to more detailed examination.

3. With the exception of Glovers Bluff, the silica potential of southern Tasmania has not been adequately investigated. The Glovers Bluff deposit is the only thoroughly explored silica deposit in southern Tasmania; its size, grade, accessibility and bulk testing characteristics combine to make it a highly significant silica resource.

4. Limited data on the Palaeozoic siliceous sedimentary rocks in western and southern Tasmania precludes any definitive statements concerning silica grades *etc.*; however the silica deposits currently worked at Beaconsfield by TEMCO are of the same age, implying that further attention should be paid to the Hastings area for silica.

REFERENCES

BROKEN HILL PROPRIETARY CO. LTD. 1977. Final report, E.L. 18/75, Forth, Tasmania. *Unpubl.Rep.B.H.P.Co.Ltd.*

BURNS, K.L. 1965. One mile geological map series. K/55-6-29. Devonport. *Explan.Rep.geol.Surv.Tasm.*

BRANDT, R.T. 1973. Summary report on Exploration Licence 8/72, Tasmania. *Unpubl.Rep.Aust.and New Zealand Exploration Company.*

BRANDT, R.T. 1974. Final report on Exploration Licence 11/73 to May 1974. *Unpubl.Rep.Aust.and New Zealand Exploration Company.*

COMALCO LTD. 1971. [Analyses from Rocky Cape area, E.L. 10/71]. Unpublished.

CONSOLIDATED GOLD FIELDS AUST. LTD. 1974. Monthly report, S.P.L. 122. *Unpubl.Rep.Consolidated Gold Fields Aust.Ltd.*

CONSOLIDATED GOLD FIELDS AUST. LTD. 1975. Final report, Glovers Bluff quartzite, S.P.L. 122. *Unpubl.Rep.Consolidated Gold Fields Aust.Ltd.*

FORSTER, M.C. 1973. Proposed silicon-ferrosilicon-magnesium industry in southern Tasmania (Unpublished).

GEE, R.D. 1971. Geological atlas 1 mile series. Zone 7 sheet 22 (8016S). Table Cape. *Explan.Rep.geol.Surv.Tasm.*

HUGHES, T.D. 1959. A deposit of fine silica at Wivenhoe. *Tech.Rep.Dep. Mines Tasm.* 3:57-59.

HUGHES, T.D. 1960. Silica deposits near Hastings. *Tech.Rep.Dep.Mines Tasm.* 4:28-34.

SHARPLES, C.E. 1979. *The Ordovician System in the Ida Bay area.* B.Sc. (Hons) Thesis, University of Tasmania : Hobart.

WILLIAMS, E. 1976. Structural map of pre-Carboniferous rocks of Tasmania. *Department of Mines, Tasmania.*

[18 March 1981]