DEPARTMENT OF MINES

SOUTH AUSTRALIA

PILLOW STRUCTURES IN AN OLDER PRECAMBRIAN HORNFELS NEAR KOKATHA, SOUTH AUSTRALIA

by

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ABSTRACT

Pillow structures are present in basic hornfels, within a complex metamorphic assemblage exposed on two low ridges northwest of Kokatha homestead, in northern Eyre Peninsula. The rocks form the basement to the Carpentarian Gawler Range Volcanics.

As the sequence was intruded by Glenloth-type granite dated at 2300 Ma, the metamorphic rocks may be late Archaean in age.

Petrological examination and chemical analyses carried out by Amdel on the pillows and interstitial breccia indicate that the rocks are probably metamorphosed pillow-lavas of basaltic or spilitic composition, deposited under water. They may be comparable with Archaean pillow-lavas in Western Australia.

INTRODUCTION

The pillow structures described in this Note were observed together with B.P. Thomson and S.J. Daly during a general reconnaissance of the region covered by the TARCOOLA and GAIRDNER 1:250 000 sheets in late 1976. We are indebted to these colleagues for material contributions to this paper.

The locality is about 6 km northwest of Kokatha homestead, some 50 km south of Kingoonya, in the northwestern portion of GAIRDNER, within the Gawler Block of Thomson (1976) (See Fig. 1). Basic hornfelses, probably partly metasedimentary, cut by sheared masses and dykes of foliated Glenloth-type granite, are exposed on two low ridges: the ridges are separated by a cover of Quaternary sediments from more prominent hills of Gawler Range Volcanics intruded by Hiltaba Granite (Blissett, 1975: 1977). Though the contact is concealed, the Gawler Range Volcanics appear to be

subaerial deposits of welded ash flow tuff, lavas and airfall tuff erupted on to a landscape of older Precambrian rocks during Carpentarian times.

A.W. Webb (in Webb and Thomson, 1977) obtained a Rb/Sr isochron of 2350 ± 33 Ma for eight total-rock samples of Glenloth Granite, using a decay constant of $\lambda Rb^{87} = 1.39 \times 10^{-11}\ yr^{-1}$. Substitution by the decay constant of $\lambda Rb^{87} = 1.42 \times 10^{-11}\ yr^{-1}$ agreed at the International Geological Congress in 1976 produces an age of 2300± 33 Ma (A.W. Webb, pers. comm.).

The age of the base of the Lower Proterozoic in north-western Australia, corrected to the same decay constant, is 2280± 89 Ma, according to Lewis et.al. (1975, p. 120). Since one of the specimens of Glenloth Granite dated by Webb (op. cit.) was collected from a dyke intruding the hornfels near Kokatha (See Fig. 1), it is possible that the pillow-lavas may be late Archaean in age.

FIELD RELATIONS

Pillow structures were first observed near the central southern edge of the western inlier (Location A on Fig. 1) where the metamorphic rocks are intruded by dykes of fine-grained granite of Glenloth type. Similar structures were later seen in several places nearby, and also at location B towards the eastern end of the inlier.

Pillows at location A are illustrated in Plates 1-3. The pillows are dark greenish-grey in colour, and are up to about 50 cm high with rounded tops and flattened bases. Some have a laminated fine-grained outer layer about 3 cm thick with a speckled appearance resembling amygdales. Yellowish-green interstitial material between the pillows appears to be metasedimentary. If so, deposition was probably subaqueous.

The attitude of the pillows in all the localities examined implies that the sequence is steeply dipping with a consistent northwesterly facing.

PETROLOGY

Specimens were examined at AMDEL by Whitehead (1977, a, b) whose observations are summarised below.

The pillows are composed of dark greenish, fine and medium grained, granular mosaics of turbid and partly sericitised plagioclase (40-60%) intergrown with green hornblende (30-60%), with a grain size ranging from about 0.1 to 0.4 mm, and the general texture is typical of hornfels. Other minerals present in minor amounts include opaque oxides, epidote and clinopyroxene. No recognisable relict textures were observed, but near the boundary of one pillow there is a zone 2-3 mm wide with a much higher proportion of hornblende and less plagioclase. The hornblende shows evidence of bleaching and alteration, grading into a zone in which it has been partly replaced by epidote along the boundary with interstitial breccia.

Whitehead (1977b) concluded that in mineralogical and chemical composition these pillows resemble metamorphosed basaltic or spilitic lavas but original microtextures have been completely obliterated (see Appendix for analyses).

The hornfels forming the interstitial material between pillows is pale green to pale buff-coloured with variable grain size ranging between 0.2 and 0.5 mm, and has a mottled fragmental fabric in part. The main constituents are epidote and andradite garnet with minor amphibole, pyroxene, plagioclase and chlorite; and traces of apatite and sphene. No relict textures can be recognised but there is a patchy variation in the relative proportions of epidote and garnet producing indistinct banding or layering due to local higher concentrations of garnet. This material contains lower concentrations of SiO_2, Al_2O_3, Na_2O and K_2O than the specimens of pillows analysed, and there is a higher proportion of CaO. Whitehead (1977b) commented that the rock resembles calcsilicate meta-sediment or skarn.

CONCLUSIONS

The characteristics of the pillow structures described in this Note

fall within the somewhat broad limits attributed to pillow lavas. The size is about average, and the shape is typical (Gary, et. al, 1973, p. 540). Concentric alignment of vesicles near the margins of pillows has also been noted in the past (Lewis 1914, pp. 592-594). It is concluded, therefore, that the basic hornfelses near Kokatha are metamorphosed basic pillow lavas which were separated by interstitial calcareous sediments.

In Western Australia, pillow lavas have been recorded in the Archaean crystalline basement (e.g. Blockley, 1975); and also in the Early Proterozoic Fortescue Group (Trendall, 1975). The pillow lavas near Kokatha are apparently older than 2300 Ma, thus inviting comparison with those in the mineralised Archaean greenstone belts of southern Western Australia.

REFERENCES

Blissett, A.H., 1975. Rock units in the Gawler Range Volcanics, South Australia. Q. geol. Notes, geol. Surv. S. Aust. 55: 2-14.

_____1977. GAIRDNER map sheet, Geological Atlas of South Australia, 1:250 000 series. Gairdner sheet SH/53-15. Geol. Surv. S. Aust. (in press).

Blockley, J.G., 1975. Pilbara Block. In : The Geology of Western Australia. Mem. geol. Surv. Western Aust., 2 : 81-93

Gary, M., McAfee, R., and Wolf, C.L., 1973. (Ed.) Glossary of Geology. American Geological Institute, Washington D.C. 805 pp.

Lewis, J.V., 1914. Origin of pillow lavas. Bull. geol. Soc. Am., 25 : 591-654.

Lewis, J.D. Rosman, K.J.R., and de Laeter, J.R., 1975. The age and metamorphic effects of the Black Range dolerite dyke. Ann. Rep. Dept. Mines Western Aust., 1974 : 120-128.

Thomson, B.P., 1976. Gawler Craton - regional geology. In: C.L. Knight (Ed.) Economic geology of Australia and Papua-New Guinea 1. Metals. Australas. Inst. Min. Metall. : 461-466.

Trendall, A.F., 1975. Hamersley Basin. In : The Geology of Western Australia. Mem. geol. Surv. Western Aust., 2 : 119-143.

Webb, A.W., and Thomson, B.P., 1977. Archaean Basement Rocks in the Gawler Craton, South Australia. Search, 8 : 34-36.

Whitehead, S., 1977a. Amdel Rept. MP 1586/77 (unpublished)

_____1977b. Chemical analyses of metamorphosed "pillow lava". Amdel Rept. MP 1/1/144 (unpublished) S. Aust. Dept. Mines Env. 2038.

LIST OF PLATES

(Photos: Susan J. Daly)

APPENDIX

SILICATE ANALYSES

ANALYSES PERCENT

	A25/77	A26/77	A27/77
SiO_2	54.24	51.46	43.03
TiO_2	1.01	1.03	.72
Al_2O_3	15.57	13.96	11.87
Fe_2O_3	2.31	2.22	7.35
FeO	6.75	7.35	2.10
MnO	.39	.49	.51
MgO	4.91	5.74	4.21
CaO	6.69	10.56	28.18
Na_2O	5.04	3.65	.65
K_2O	.58	.65	.09
P_2O_5	.08	.08	.10
H_2O+	1.52	1.81	.78
H_2O-	.22	.27	.14
CO_2	-	-	-
S	-	-	-
Total	99.31	99.26	99.73

TRACE ELEMENTS IN PPM

	A25/77	A26/77	A27/77
Au	<0.05	<0.05	<0.05
Cu	100	48	15
Co	50	50	26
Ni	122	110	86
Cr	260	290	180
V	320	320	290
Pb	14	12	16
Rb	24	28	6
Sr	180	140	70
Ba	270	400	45
Zr	40	50	40
Zn	155	150	100

Sample A25/77 - Core of pillow

Sample A26/77 - Margin of pillow

Sample A27/77 - Interstitial Material

Analysts: O.B. Hopton et.al. Australian Mineral Development Laboratories

(Analyses - cont.)

XRF : SiO_x, TiO_x, Al_2O_3, Fe_2O_3, CaO, K_2O, P_2O_5

Chemical analysis : FeO, MnO, MgO, Na_2O, H_2O+, H_2O-

XRF (Dry powder) : Pb, Rb, Sr, Ba, Zr, Zn

AAS : Cu, Co, Ni, Cr, V

Aqua regia + A.A.S. : Au

(Amdel Scheme H3/1)

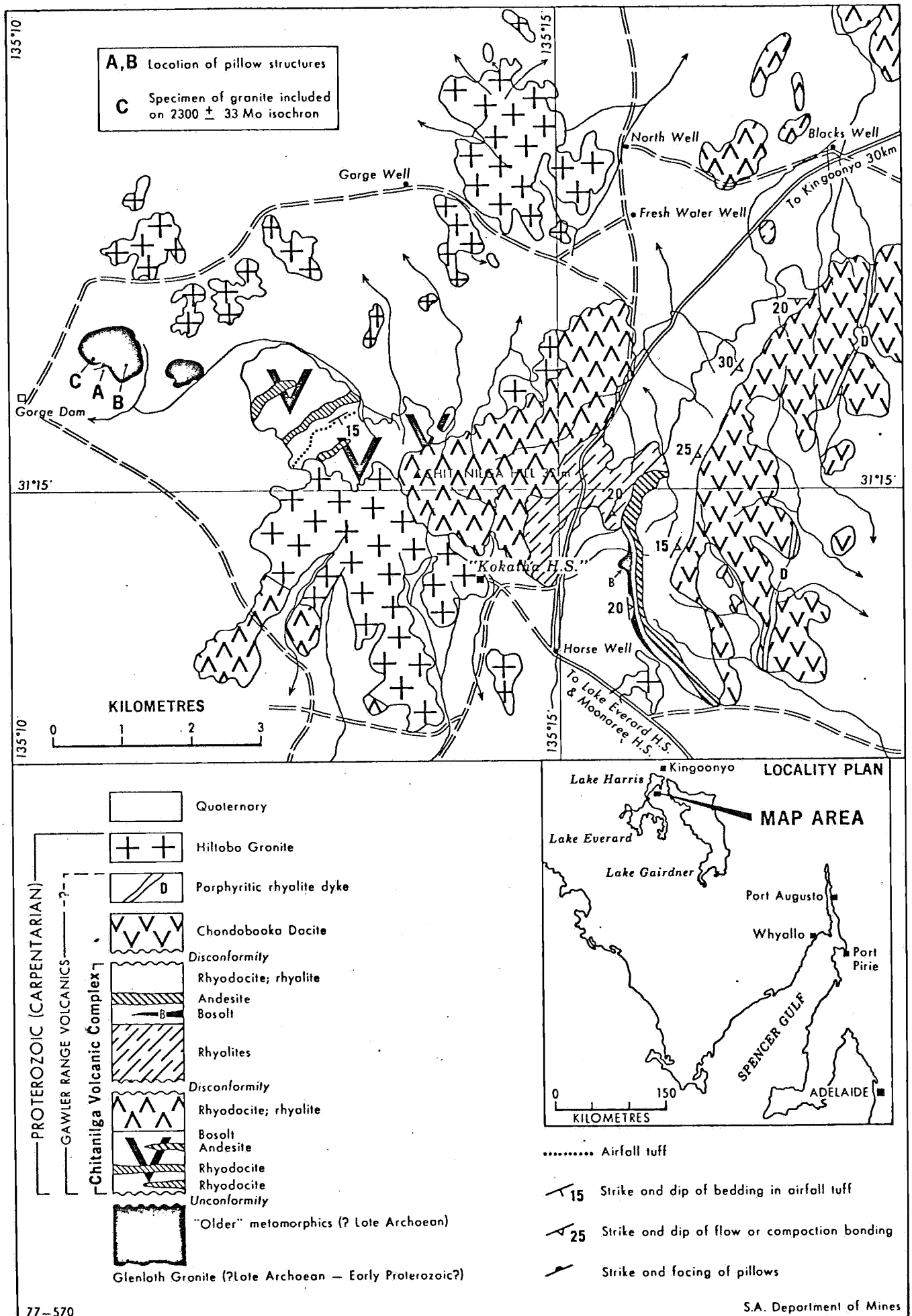

Fig. 1 Geological map

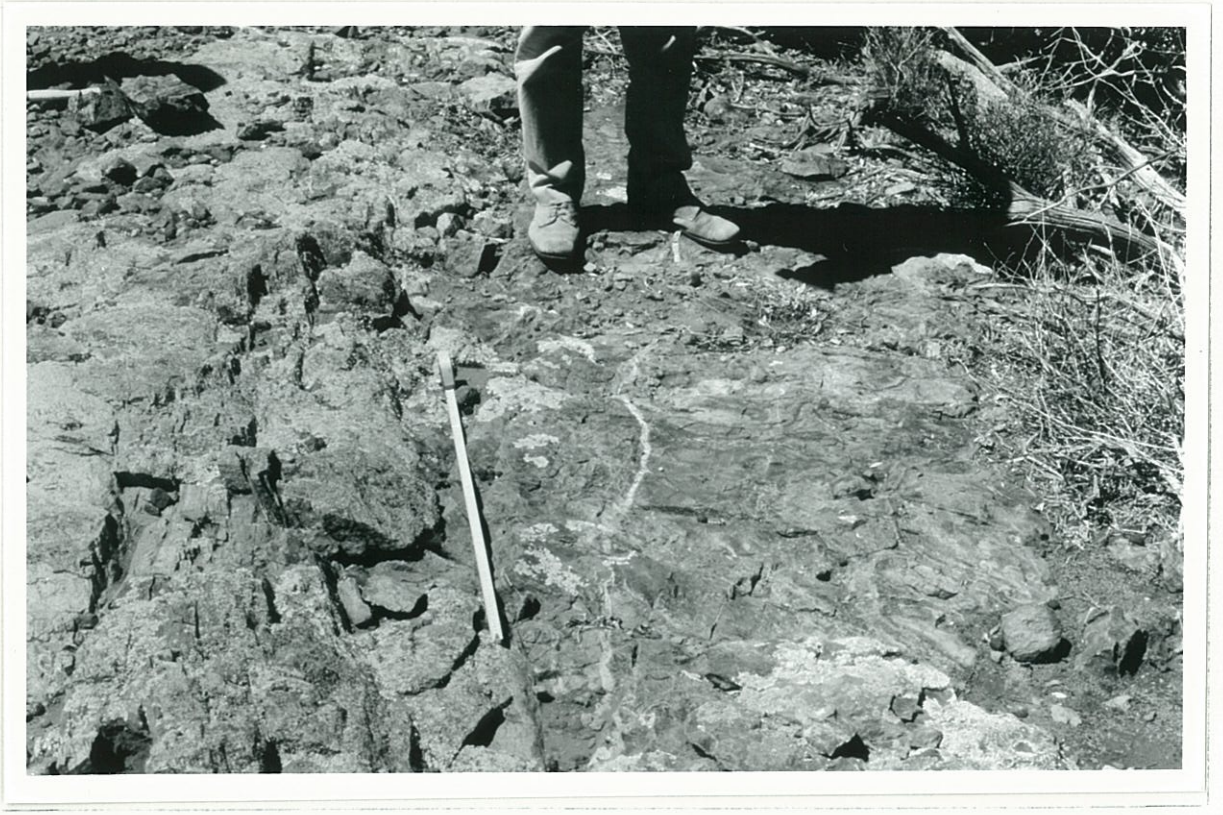

Plate 1. Dyke of Glenloth-type leucocratic granite intruding hornfels with pillow structures (Tape marks contact).

Plate 2. Pillow structures. Note vein of microgranite thrown off by dyke (Length of tape 30 cm).

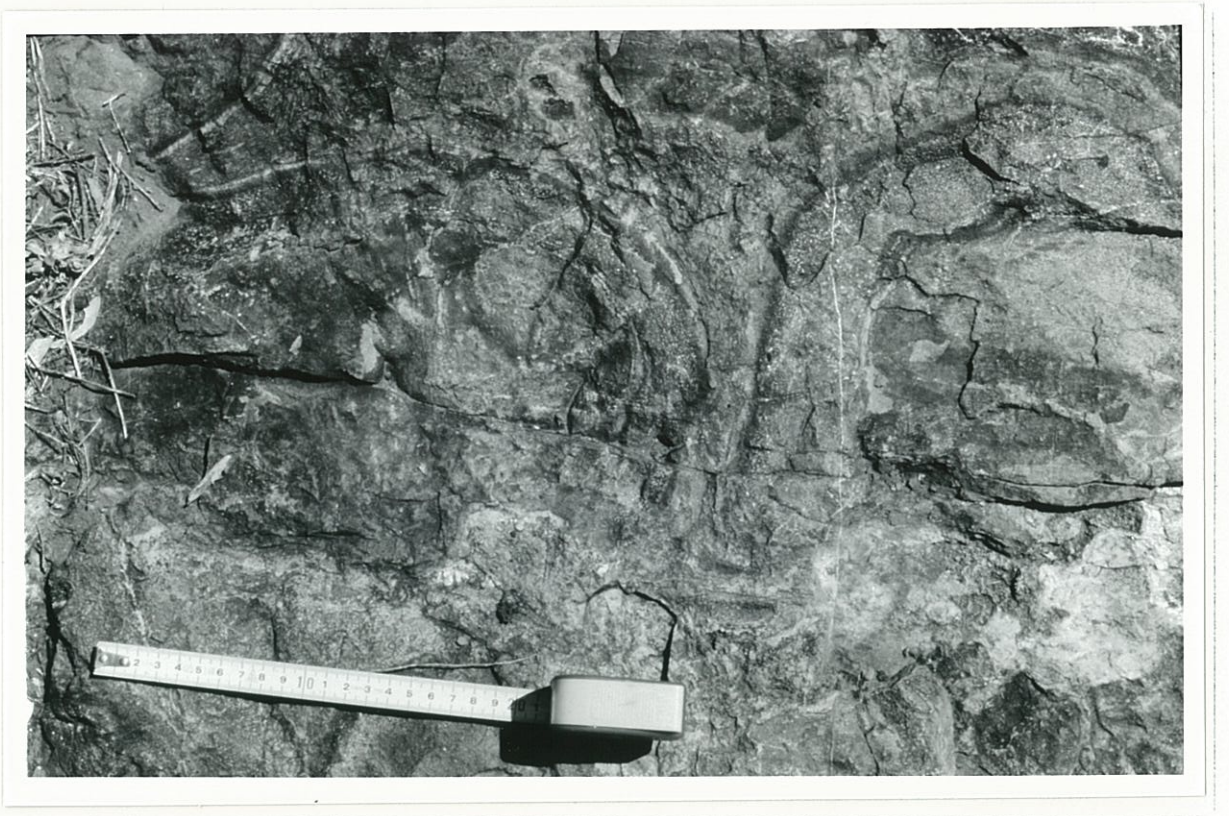

Plate 3. Close-up of pillow structures