DEPARTMENT OF MINES
SOUTH AUSTRALIA

THE ASSOCIATION OF MINERALISATION WITH BRECCIA AND SOME SOUTH AUSTRALIAN EXAMPLES

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ABSTRACT

Breccias of sedimentary, tectonic and volcanic origin occur in South Australia associated with a variety of phenomenon including epigenetic mineralization in many forms. Examples are provided to illustrate the diversity of breccia-ore geology.

INTRODUCTION

Breccia; rock made up of angular, coarse fragments, is produced in a variety of environments by several geological processes. Breccias are associated with many different kinds of mineral deposits.

Breccias of sedimentary, tectonic and volcanic affiliation occur in South Australia, variously associated with manganese, zinc, copper, asbestos, mercury, uranium, iron, lead, barite, and opal deposits.

This article is written with the purpose of indicating variety in the geology of breccia and variety in associated mineralization in South Australia.

Slide numbers, e.g. (slide 24), refer to photograph slides, detailed in the appendix, from the Geological Survey of South Australia, slide collection.

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SEDIMENTARY BRECCIA

Sedimentary breccia may be formed by lithification of scree or talus, by dessication during sedimentation and by slumping during lithification.

Very coarse sedimentary breccia of Quaternary age has been described by Crawford (1965) from Black Point, ten miles east of Whyalla. The breccias (slide 1) are believed to have accumulated as scree at the base of a fault scarp and later cemented by calcrete. The scree iron ore deposits of Iron Monarch formed in a similar manner.

The Montacute Dolomite formation of the Adelaide System is composed in part of a magnesite breccia, (slide 2). Forbes (1960, 1961) describes the breccia as "a poorly sorted mixture of dolomite and magnesite fragments in a dolomitic matrix." The breccia is considered to have formed during deposition by mud-cracking and fragmentation due to dessication and incorporation of the fragmental material in later influxes of sediment.

Slump breccias have been described from areas in the Flinders Ranges surrounding diapirs. For example, south of the Beltana Diapir the Wonoka Formation features siltstone-limestone breccia representing local slumping of semi-consolidate sediment. Thickening of the breccia towards the diapir indicates that this structure was a focus of instability during upper Marinoan times (Leeson, 1970).

TECTONIC BRECCIA

Tectonic breccia may be formed by folding, faulting and forceful intrusion. Fragmentation is accomplished by movement of large masses of rock past one another. The boundary materials are literally ground up.

The movement that occurs along a fault surface may give rise to a fault breccia. For example in the barite deposit at the Oladdie Mine, fifteen miles north of Orroroo, which has formed by open space filling of fault fractures, (Reid, 1969), fragments of wall rock in a groundmass of barite (slide 3) and fragments of barite in a groundmass of barite (slide 4), testify to successive fault movement and repeated influx of barite.

The movement that occurs along fold surfaces may give rise to a fold breccia or riebungsbreccia (Pettijohn, 1957, p. 281). These breccias result from sharp folding of thin bedded brittle layers between which are incompetent plastic beds. An east-west trending elongate dome is the major structure of the Burr complex crush zone (Barnes, 1970). Several phases of intense folding are responsible for brecciation of the Burra Group in the core zone; siltstone and shale being brecciated and carbonate units partly brecciated and partly displaying plastic flow.

The movement associated with forceful intrusion gives rise to breccia exemplified by the diapiric breccia of the Flinders Ranges (Dalgarno & Johnson, 1968). (Slides 5 & 6). The Callana Beds, a thick sequence of thin bedded incompetent, saline carbonate siltstones, have been injected upwards into the overlying strata, flowage being facilitated by water-saturation and confinement during sedimentary loading between the rigid basement and very thick basal sandstone of the Burra Group. Intrusion of the breccia is analagous to that of salt plug emplacement (Coats, 1964).

VOLCANIC BRECCIA

Volcanic breccia is a rock composed predominantly of angular fragments of any rock greater than 2 m.m. in size, the brecciation and/or emplacement of which was the result of volcanic action.

It includes three major types of breccia which may be subdivided as follows: (Fisher 1960, 1961, 1966: Wright and Bowes, 1963).

I. Autoclastic volcanic breccia - formed by fragmentation of semi-solid or solid lava by explosive disruption by the gases contained within the lava or by movement of the lava
   A. Friction breccia (by autobrecciation of lavas)
   B. Explosion breccia (disruption by gas explosion).

II. Alloclastic volcanic breccia - formed by fragmentation of any pre-existing rock by volcanic processes beneath the surface.
   A. Intrusion breccia (caused by intrusion of magma).
   B. Explosion breccia (caused by gas explosion)
   C. Intrusive breccia (show cross-cutting relationships).

III. Pyroclastic breccia - formed from the solid fragmental material thrown into the air during volcanic eruptions.
   A. Vulcanian breccia (aerial ejection by explosive eruption).
   B. Pyroclastic - flow breccia (deposited from the suspension of fragments in volcanic gases)
   C. Hydrovolcanic breccia (formed by phreatic eruption).
   D. Vent agglomerate and vent breccia.

Autoclastic and pyroclastic breccias are featured essentially within the vent or cone complex facies of volcanic provinces and have been described along with alloclastic intrusion breccias by Turner (1970) from the Gawler Ranges Volcanic Complex of the Northern Eyre Peninsula region. The complex consists of an assemblage of volcanics of rhyolitic to rhyodacitic composition, forming a conformable succession of predominantly ash-flow tuffs intercalated with air-fall tuffs and lava flows.

A number of breccia masses often with an intrusive appearance occur in the area around Mount Painter in the Northern Flinders Ranges (slide 7). Some are roughly circular, vertical pipe-like bodies 100-200 feet in diameter having sharp cross-cutting contacts with the surrounding rocks. Coats proposes (in Coats and Blissett, 1971) that these masses were formed by the explosive effects of gas filled magma. Dickinson at al (1954, P.87) propose that some of the masses, showing markedly discordant relations were formed by forcible injection of crushed material (Slide 8).

DIFFERENTIATION CRITERIA

Criteria for the recognition of different types of breccia include structural features, character of the fragments, and the composition and texture of the groundmass (Parsons, 1969).

Structural features such as form dimensions and associated sedimentary tectonic or igneous structure are important in determining origin.

Characters of the fragments that may be useful include size, shape lithology, proportions of essential, accessory and accidental fragments, texture degree of sorting and the presence of fossils.

Characters of the groundmass that may be useful include composition, texture, colour, porosity, degree and type of alteration and proportion of groundmass to fragments.

BRECCIA ASSOCIATED WITH EPIGENETIC ORE DEPOSITS

In instances where breccias are associated with ore deposits, two relationships are significant. First that breccia development was prior to and independant of mineralization. In this case brecciation is considered as ground preparation allowing later ready ingress of mineralizing solutions either from above, or beneath or the sides. Secondly that breccia development was coincident with mineralization, brecciation resulting from either mineralization stoping (Lock, 1926), chemical brecciation (Sawkins, 1969) or the corrosive action of hydrothermal solutions as in the breccias associated with porphry copper-type ore deposition (Bryner, 1961).

Pyrolusite (MnO_2) fragments in a groundmass of Ripon Calcrete (slide 9) constitutes a manganiferous breccia near Broken Hill. Fragments of shale in a groundmass of pyrolusite (MnO_2) form the breccia occuring in the Eregunda manganese mine (slide 10).

Zinc ore bearing sphalorite (ZnS) from the Wallaroo mines occurs in the form of breccia (slide 11).

Copper minerals are present in several forms in a number of breccia masses. Native copper (Cu) is featured in calcareous breccia in the Dome Rock Mine. (slide 12). Chrysocolla ($CuSio_3 2H2o$) bearing breccia (slide 16) occurs in the oxidised zone of this mine. Malachite ($Cu_2CO(OH)_2$) is the most common occuring copper mineral associated with breccia. It is present along with Smithsonite ($ZnCO_3$) in the Billy Springs mine breccia (Slide 13) and in carbonate breccia in the Ediacara mine (slide 14) and the Cuncliffe Copper Show (slide 15).

The Oraparinna Asbestos Mine occurs within the diapiric breccia of the Oraparinna Diapir (Slide 17).

Cinnabar (Hgs) and tennantite (Cu, Fe, Zn, Ag) $_{12}As_4S_{13}$) occur in a vein quartz breccia at the Moro mines (slide 18).

The breccia masses of the Mount Painter region are notably rich in uranium minerals such as torbernite ($Cu(UO_2)_2(PO_4)_2$ 8-$12H_2O$) (Slide 19).

Hematite jasper breccia occurs at Iron Monarch in the large iron ore region of Eyre Peninsula (slide 20)

Youngs Cobalt mine is situated in the Blinman Dome Diapir and is associated with breccia (slide 21).

Galena (Pbs) bearing breccia is worked at the Bukaby Mines in the eastern Flinders Ranges (slide 22).

Also noteworthy is the sedimentary breccia or "cement layer" which is host to the matrix opal in the Andamooka Opalfield.

CONCLUSIONS

In the preceding discussion an attempt has been made to indicate variety of phenomenon in examples of South Australian breccias and in their associated epigenetic ore deposits with mention of the criteria useful in evaluating their geology. Their variety in occurence results from a wide range of processes the understanding of which is fundamental in the economic geology of the state.

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APPENDIX - LIST OF SLIDES

NO.	DEPT. SLIDE NO.	HUNDRED OR GRID	DESCRIPTION	LOCALITY
1	6572	CULTANA	Quartz-sedimentary breccia	Black Point.
2	9054 ✓	MINERAL	Magnesite breccia	Port Augusta (Burra Group)
3	9053 ✓	MINERAL	Barite breccia	Mount Carey
4	9052 ✓	MINERAL	Brecciated barite	Oladdie mine
5	5880	MAP S.A.	Distribution of diapirs	Flinders Ranges
6	8721	K.S	Ferruginized idapiric breccia	Peak to W.S.W. of Mount Roebuck
7	9044	MAP. S.A.	Mount Painter Province	Flinders Ranges
8	8772	K.S	Haematite-breccia (radioactive)	Portal No.4 adit, E. Painter
9	9067	COOMOORO	Pyrolusite-calcrete breccia	Broken Hill: (MUS.2401)*
10	9051 ✓	MINERAL	Shale-pyrolusite breccia	Eregunda mines
11	9050 ✓	WALLAROO	Zinc ore with sphalerite	Youngs shaft, Wallaroo (MUS.1706)
12	9049 ✓	7L.	Native copper in breccia	Dome Rock (MUS.2836)
13	9047 ✓	KS.	Malachite breccia	Billy Springs Mine
14	9046 ✓	SJ.	Malachite breccia	Ediacara mine (MUS.2853)
15	9045 ✓	KADINA	Malachke breccia	Cuncliffe Copper Show (MUS.597)
16	9048 ✓	7L.	Chrysocolla breccia	Dome Rock (MUS.2827)
17	9059 ✓	MINERAL	Asbestos in diapiric breccia	Oraparinna Asbestos Mine
18	9057 ✓	K.S	Torbenite breccia	Moro mines (MUS. 4156)
19	9057 ✓	K.S	Torbenite breccia	East Painter
20	1124	MANCHESTER	Haematite jasper breccia	Iron Monarch
21	9056 ✓	MINERAL	Breccia	Youngs Cobalt Mine
22	9055 ✓	MINERAL	Galena breccia	Eukaby mines.

* MUS. NO'S. Refer to samples in the Geological Survey of South Australia Museum.