DIAPIRS AND DIAPIRISM IN THE ADELAIDE 'GEOSYNCLINE'
SOUTH AUSTRALIA

by

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FRONTISPIECE -

ARKABA DIAPHRAGM; 1.4 cm = 1 km
Aerial photograph, SVY. 1081, 0246
Dept. Lands, S. Aust.
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PhD thesis by Trev J Mount, 1975

NOTE ON PUBLISHED GEOLOGICAL MAPS

The regional geology of the study area, the Flinders- Mt Lofty Ranges, is well described by a series of 1:250,000 map sheets published by the Geological Survey of South Australia (Department of Mines, Adelaide).

Copies of these maps are included in the pocket at the back of the original thesis, but they cannot be scanned and reproduced here due to copyright restrictions.

Prior to 1975, the principal area of known diapirs was covered, from north to south, by the following geological map sheets:

**Copley**
1973: S. A. GEOLOGICAL ATLAS SERIES SHEET SH 54-9 ZONES 5 & 6

**Parachilna**
1966: S. A. GEOLOGICAL ATLAS SERIES SHEET H 54-13 ZONES 5 & 6

**Orroroo**
1968: S. A. GEOLOGICAL ATLAS SERIES SHEET SI 54-1 ZONES 5 & 6

**Burra**
1964: S. A. GEOLOGICAL ATLAS SERIES SHEET I 54-5 ZONES 5 & 6

**Adelaide**
1969: S. A. GEOLOGICAL ATLAS SERIES SHEET SI 54-9 ZONES 5 & 6

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ABSTRACT

Approximately 180 diapirs define a 500 km belt coincident with the Flinders-Mount Lofty Ranges. New observations on these structures are prefaced by reviews of the concept of diapirism in general and of the history and regional geological setting of the province — the Adelaide 'Geosyncline'. The proposed model for diapirism in the 'Geosyncline' is based on a detailed map of the Arkaba Diapir.

Primary control of diapir distribution in the trough can be related to fracture patterns in the pre-source-bed rocks.

Outcrop of diapiric material is distinctive over a wide area, and may be accentuated by patterns of vegetation. Weathering is deep and intense but cap-rock or solution megabreccias are absent.

Typical forms are very complex, varying from massifs, domes, dykes, and plugs, shapes that have been controlled by host-rock anisotropy, notably patterns of fracture.

Diapir/host-rock contacts are invariably abrupt and coincide with planes of weakness in the host. The contacts, despite sculpting and quarrying by invading diapiric material, can often be matched in 'continental drift' type reconstructions across the cores. Host strata are rarely brecciated or upturned against a diapir, illustrating the passive nature of the intrusions. Where such deformation occurs, it usually pre-dates diapirism and is due to faulting. Permitted intrusion under local extension in the cover, plausibly induced by regional compression, is implied. Alteration of host-rock adjacent to contacts is absent but for minor dolomitization in certain zones.

The intrusive material is an intensely mixed chaotic breccia but one which includes many well rounded and subspherical xenoclasts, from kilometres across to the finest dust. The size spectrum appears to obey Rosin's Law of Crushing. The breccias, but for rare basement and host-rock xenoclasts, involve a restricted and characteristic range of shallow-marine lithologies including terrigenous clastics, carbonates (especially dolostones), and saline evaporites. This suite may well be assigned to the Callanna Beds of Late Precambrian age.

Petrographic studies have revealed a suite of metamorphic minerals, notably carbonate, chlorite, clay, felspar, haematite, magnesioriebeckite, quartz, stilpnomelane, and talc, developed in the core rocks. All mineral components may reasonably have been derived by simple processes entirely from rocks of the type that comprise typical xenoclasts. Many reactions involved dedolomitization and/or saline evaporites. A low pressure, hypersaline, aqueous, oxidative metamorphic environment (zeolite facies) is indicated; replete with CO₂, open-system, and low temperature (150°-250°C-300°C). Affinities are with natural hydrothermal and geothermal systems.

Igneous rocks with a wide range of ages occur in the cores and include both intrusive and extrusive types, mainly basic to intermediate in character. They are essentially xenolithic but include some in situ post-diapiric intrusions. The occurrence of igneous rock is fortuitous and non-essential to diapirism.

Typical breccias have a banded fabric and other features such as the shaping, disruption, mixing, and alignment of xenoclasts that must be attributed to flow. Movement was slow, rather passive, and plug-like, described by non-Newtonian, Andradean law.

Mobility of the source material, rather than factors such as density, was paramount to diapirism. The mobility is explained by the former presence of saline evaporites in the interstices of the breccias and by appeal to the concepts of dilatancy, fluidization, and rheology. The overburden was relatively brittle, its weight the prime driving force to the intrusions. Emplacement was at least partly syn-tectonic, linked to pulses of deformation of the cover, as well as to basement evolution in the 'Geosyncline'. Decollement at the source layer is implied. The host was not explosively breached in the manner of a diatreme; the diapirs are not carbonatites.

Although further problems have been outlined, a study of diapirs in the Flinders-Mount Lofty Ranges has clarified many aspects of the global theory. The essence of the new observations is embodied in a proposed classification of intrusions that includes diapirs.
This thesis contains no material which has been accepted for the award of any other degree or diploma in any University, nor, to the best of my knowledge and belief, does it contain any material previously published or written by another person, except where due reference and acknowledgement is made in the text.
ACKNOWLEDGEMENTS

A special expression of gratitude is due to Dr. Brian Daily who initiated this project and gave every possible assistance towards its completion.

The participation of other members of the Department of Geology and Mineralogy in some stages of research and presentation is recognized. People outside the Department who have assisted include Drs. T. Deans, J. Ferguson, N. Sobolev, and I.C.F. Stewart, Messrs. R.P. Coats, and D.C. Nicholls, and the family Ireland of Hawker. The services of the Barr Smith Library (Miss C. Walker) were invaluable. Typing is by Helen Ball, the final copy by Brenda Froiland.

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NOMENCLATURE

Physical units and their abbreviations conform to the S.I. system (Chiswell & Grigg, 1971). The preferred bedding classification is that of McKee and Weir (1953, p.383), while the grade scale of Folk (1968, p.25), after Wentworth (1922), has been the most applicable. Sandstone classification is after Pettijohn (1957, p.291). For a classification of fine-grained fragmental rocks that of Dunbar and Rodgers (1957, p.166), after Ingram (1954), has been adopted. Igneous rock terminology is that of Morgan (1964). Rock colour is related to the chart of Goddard et al. (1951). CAPITALIZED map titles define a 1:250,000 sheet (10° lat., 15° long.), of the Department of Mines, Geological Survey of South Australia; lower-case titles refer to their 1:63,560 sheets (15° Int., 30° long.). The spelling Romanian is used in preference to Roumania or Romania. A distinction is drawn between the mineral dolomite and the rock, dolostone.

Attention is drawn to the following diapir nomenclature: a rock-mass from which the material of a diapir appears to have largely derived is loosely referred to as the source-rock in the general case, or the source-beds where this is thought to have been a horizontal, laterally extensive lens of sedimentary material. More than one horizon, at various stratigraphic levels, may have contributed to the diapir(s) and not all of any layer may have been donated. All material above a given source bed is referred to as its overburden. The overburden may be termed the host-rock to diapirs derived by migration into it of source-rock material. The term host-rock replaces rim-rock, prevalent in the literature but often thought to be (geometrically) inappropriate. It contrasts with the core-rock of the actual diapir. Tectonic nomenclature recognizes a sedimentary cover and a crystalline basement as typical of basins or troughs of extensive sedimentation. It is important to note that in diapiric provinces the 'overburden' is not synonymous with the 'cover' but that it is included within it, underlain by a source-bed(s) and, potentially, under the (or under the oldest) source-bed by a portion of the cover that cannot be 'overburden' but forms, with the basement, a substrate to the (or to the lowest) source-bed. Where source material was formerly an inactive diapir then it is said to have been reactivated.

The distinction between material that has itself been 'intruded into' and material that has been 'intruded by' another body is emphasized; the phrase 'the intruded sequence' is ambiguous.

The simplicity of the term 'diapir' appears preferable to the 'diapiric structure' - used so frequently in the literature.

Again, the term raft is often applied locally to what are thought to be discontinuous masses of rock, 'out of stratigraphic context' and apparently 'floating' in a matrix of finer breccia in the core-rock of the diapirs. In this work, however, although 'raft' may be used and especially in quote, the synonyms xenolith, xenoclast, inclusions, or block may be variously utilized, particularly where analogy with igneous intrusives needs to be emphasized.

It is intended that Fig. 4 be of general reference use throughout the text and thus is not always cited in detail.

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1 The definition of a diapir is discussed in Chapters 1 and 4.