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The Giles mafic–ultramafic complex and environs, western Musgrave Block, central Australia

Preface

The Giles Complex comprises a series of over twenty layered mafic–ultramafic intrusions and faulted segments emplaced within the southern granulite terrane of the Musgrave Block, central Australia, over an east–west strike length of some 500 km—constituting the largest mafic–ultramafic intrusive suite on the Australian continent. Earlier documentation of this suite during the 1960s included 1:250 000 mapping by the Geological Survey of Western Australia and the South Australia Department of Mines, and local detailed studies by staff and students of the University of Adelaide. The papers presented in this issue report some of the principal results of AGSO's Musgrave project, initiated in 1987 as a specialised study of the layered mafic–ultramafic intrusions of the Giles Complex and continued in 1990 within the framework of the National Geoscience Mapping Accord. Field work in the western Musgrave Block concentrated in the Tomkinson Ranges–Blackstone Range–Jameson Range region of Western Australia and South Australia. Geological mapping was accompanied by multidisciplinary investigations, comprising detailed field mapping of surface deposits and vegetation patterns, structural studies, comprehensive petrological studies based on electron-probe analyses, pressure–temperature studies, U–Pb and Sm–Nd isotopic analyses, whole-rock geochemistry, and remotely sensed studies using Landsat-5 TM and Geoscan Mk I. A list of reports, publications and maps released by the Musgrave project follows. Geological and environmental maps on the scales of 1:100 000 and 1:50 000 will be released separately from this issue.

In view of the broad contemporaneity of the western Musgrave Block and the ~1.3–1.0 Ga Grenville belt in North America, Tony Davidson, an authority on the Grenville system, was invited to write a review of this terrane. Geoff Clarke was invited to review Grenville-age belts in Australia and Antarctica, on the basis of his personal experience in the Albany–Fraser, Musgrave, Arunta, Rudall and Antarctic terranes. Other papers are organised according to a thematic sequence, including the geological framework and petrology of the Giles Complex, pre-Giles Complex granulite facies gneisses in the type area of Mount Aloysius, geochemical studies, structural and palaeo-pressure/temperature evolution of host rocks of the Giles Complex, boundary thrust faults of the western Musgrave Block, and multispectral, remotely sensed studies of the Giles Complex and associated granulites. Papers on the isotopic ages of key units in the Musgrave Block will appear in a future issue of the *AGSO Journal*, reporting a probable ~1.08 Ga age for the Giles Complex and Tollu Group volcanics (Sun et al. in press).

Some of the principal conclusions arising from the project and reported in this issue include (1) recognition of vertical crustal zonation pattern in the western Musgrave Block, ranging from ultramafic-dominated bodies at deep crustal levels along the Woodroffe Thrust, to layered gabbro–pyroxenite intrusions, crystallised at ~6 kb, to silica-undersaturated troctolite intrusions at shallower crustal levels (< 4 kb) to the west and south; and to supracrustal levels, where the probably coeval volcanics of the Tollu Group (~1.08 Ga) were extruded in the southwest; (2) identification of the western extension of the Woodroffe Thrust north of the Tomkinson Ranges; (3) documentation of original magma fractionation trends, which define mafic–ultramafic bodies as originally separate intrusions, rather than fault segments of an original lopolith; (4) recognition of multiple intrusion of magma batches, including injection of late ultramafic increments into resident gabbro magma chambers and of late doleritic sills into chambers of above-solidus gabbroic magma; (5) interpretation of silica-undersaturated iron-rich fayalitic olivine–plagioclase–magnetite troctolite suites in terms of high-pressure (> 10 kb) fractionation of orthopyroxene from parent magma and emplacement of the fractionated liquids under low-pressure (< 4 kb), high-oxygen fugacity conditions; (6) isobaric cooling of mafic–ultramafic magmas; (7) resolution of seven deformation stages and multiple high-pressure events in the western Musgrave Block, including identification of ~550 Ma sub-ecologite facies rocks (~14 kb) above the Woodroffe Thrust; (8) extensive recrystallization of Giles Complex mafic rocks into mafic granulites in conjunction with intrusion of granitic veins; (9) geochemical characterisation of several granite magma types and at least four geochemically distinct mafic dyke swarms; (10) recognition of partial melting features in pre-Giles Complex granulites induced by high temperature emplacement of the mafic–ultramafic intrusions; (11) chemical characterisation of pre-Giles Complex orthogneisses and paragneisses, which include quartzite and minor pelitic and calc-silicate gneisses; and (12) correlations of remotely sensed multispectral data with a range of bedrock and surface deposit types.

The Musgrave project has not been an easy one to pursue, from the logistic point of view, owing to limitations on access into Aboriginal reserve land, as well as the geological complexities inherent in the study of multiply deformed high-grade metamorphic terranes. However, the project enjoyed the goodwill of a dedicated team, most of whom worked beyond the call of duty. I am grateful to my colleagues Chris Ballhaus, Geoff Clarke, John Creasey, Erwin Feeken, Alastair Stewart, John Sheraton, Shen-Su Sun, and John Vickers for their efforts and achievements. I thank members and field guides of the Ngganyatjarra and Pitjantjatjarra Aboriginal tribes and community coordinators, Ruth Raintree, Murray Wells, Diana James, and, in particular, Rob Shelton—without whose support and friendship, field work may not have been possible.

Andrew Glikson
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Reports, publications and maps released by the Musgrave Project (excepting papers of this issue)

Ballhaus, C.G., 1992. Petrology of the Giles Complex, Musgrave Block, central Australia: the Jameson, Blackstone, Bell Rock, Murray, The Wart, Latitude Hill and Hinckley intrusions. Australian Geological Survey Organisation, Record 1992/73.

Ballhaus, C.G. & Glikson, A.Y., 1989. Magma mixing and intraplutonic quenching in the Giles Complex, central Australia. Journal of Petrology, 30, 1443–1469.

Ballhaus, C.G. & Berry, R.F., 1991. Crystallization pressure and cooling history of the Giles layered igneous complex, central Australia. Journal of Petrology, 32, 1–28.

Ballhaus, C.G., Glikson, A.Y. & Keays, R.R., 1992. Magmatic and metamorphic evolution and economic potential of the mafic/ultramafic Giles Complex, western Musgrave Block, W.A. BMR Research Newsletter, 16, 6–9.

Clarke, G.L., 1992. Field relations and tectonic history of the Hinckley Gabbro, felsic to mafic granulites and ganitoids, western Hinckley Range and Champ de Mars areas, Tomkinson Ranges, Musgrave Block, Western Australia. Bureau of Mineral Resources, Australia, Record 1992/33.

Clarke, G.L., Buick, I.S. & Glikson, A.Y., 1992. Contact relationships and structure of the Hinckley Gabbro and host rocks, Giles Complex, western Musgrave Block, W.A. AGSO Research Newsletter, 17, 6–8.

Clarke, G.L, Stewart, A.J. & Glikson, A.Y., 1993. High-pressure eclogite-facies metamorphism in the western Musgrave Block, central Australia. AGSO Research Newsletter, 1, 6–7.

Feeken, E., 1991. Environmental mapping in BMR: Cainozoic deposits, landforms and vegetation in the Tomkinson Ranges. BMR Research Newsletter, 14, 7–8.

Feeken, E., 1992. Notes on the 1:100 000 environmental map of the Tomkinson Ranges, Western Musgrave Block, central Australia. Australian Geological Survey Organisation, Record 1992/34.

Glikson, A.Y. & Ballhaus, C.G., 1989. Significance of ultrabasic components of the Giles Complex, central Australia. BMR Research Newsletter, 10, 4–6.

Glikson, A.Y. & Stewart, A.J., 1992. Mapping in high grade terranes: use of remotely sensed data and airborne geophysics. BMR Research Newsletter, 16, 22–23

Glikson, A.Y., 1993. Landsat-5 Thematic Mapper image correlations: application to NGMA mapping of the western Musgrave Block, central Australia. 7th Australasian Remote Sensing Conference, Melbourne, 6 pp.

Glikson, A.Y., 1994. Landsat-5 Thematic Mapper image correlations: application to NGMA mapping of the western Musgrave Block, central Australia. Australian Geological Survey Organisation, Record 1994/17.

Glikson, A.Y. & Mernagh, T.P., 1990. Significance of pseudotachylite vein systems, Giles basic/ultrabasic complex, Tomkinson Ranges, western Musgrave Block, central Australia. BMR Journal of Australia Geology & Geophysics, 11, 509–519.

Glikson, A.Y., Ballhaus, C.G., Goleby, B.R. & Shaw, R.D., 1990. Major thrust faults and crustal zonation of the middle to upper Proterozoic crust in central Australia. NATO Advanced Study Institute on Exposed cross sections through the continental crust. Kluwer Academic Publishers, Netherlands, 285–304.

Glikson, A.Y., Ballhaus, C.G. & Pharaoh, T., 1990. The Giles Complex, central Australia: new insights into tectonics and metamorphism. BMR Research Newsletter, 12, 18–20

Glikson, A.Y., Stewart, A.J. & Feeken, E., 1995. 1:100 000 Geological map of the Giles Complex and environs, western Musgrave Block, central Australia (3 plates), in press.

Pharaoh, T.C., 1990. Aspects of structural geology of the Giles layered mafic/ultrmafic complex, Tomkinson Range, Musgrave Block, central Australia. Bureau of Mineral Resources, Australia, Record 1990/6.

Stewart, A.J., 1993. Extension of the Woodroffe Thrust into, Musgrave Block, Western Australia. AGSO Research Newsletter, 18, 5–6.

Stewart, A.J., in press. Bates 1:100 000, Western Australia, Explanatory Notes. Australian Geological Survey Organisation, Record.

Stewart, A.J. & Glikson, A.Y., 1991. The felsic metamorphic/igneous core complexes hosting the Giles Complex. BMR Research Newsletter, 14, 6–7.

Sun, S.S. & Sheraton, J.W., 1992. Zircon u/Pb chronology, tectono-thermal and crust-forming events in the Tomkinson Ranges, Musgrave Block, central Australia. AGSO Research Newsletter, 17, 9–10.