Structure
Foliation trends throughout the southern granulite and northern gneiss terranes are at large angles, and hence are unrelated, to the east–west mylonite zone (Fig. 10). The lineation in the mylonite zone is almost everywhere subhorizontal to gently west-plunging, and indicates an east–west movement direction. Kinematic indicators were observed at only four locations (Fig. 10): two indicate movement of the top block to the west, and two indicate movement of the top block to the northeast. The scarcity of shear indicators suggests that the fabric is not markedly asymmetrical, because large strain produced almost parallel shearing and flattening planes.

Tectonic significance
The east–west lineation and hence movement direction in the mylonite zone are nearly parallel to the general strike of the mylonite zone, and differ from the northward overthrusting recorded on the Woodroffe Thrust in the Amata and Kulgera areas. Nevertheless, the low dip of the Bates mylonite zone, and the thickness of the mylonite exposures, resemble features of the Woodroffe Thrust, and support the interpretation that the thrust extends into Western Australia. Mapping of the hinterland unmapped isolated exposures north of the Mann Range in the southwest Petermann Ranges 1:250,000 Sheet area should locate the Woodroffe Thrust there also.

For further information, contact Dr Alastair Stewart (Minerals & Land Use Program, AGSO), or Dr Geoff Clarke (Department of Geology & Geophysics, University of Sydney).

High-pressure granulite to eclogite-facies metamorphism in the western Musgrave Block, central Australia
Recent studies of the central Australian Precambrian crust in the western Musgrave Block have revealed assemblages representing the transition from garnet–mafic granulite to the eclogite facies. These assemblages reflect two stages of pressure increase from about 400 to above 1000 MPa: (1) garnet–hornblende assemblages of felsic gneisses formed under high-pressure granulite-facies conditions of ca 1100 MPa (T = 650°C), postdating 1185-Ma granites and coinciding with penetrative mylonitic D3 deformation; (2) garnet–clinopyroxene assemblages that developed under subsequent eclogite-facies conditions of ca 1300 MPa (T = 700–750°C) pervade mylonites and form coronas around orthopyroxene in post-D3 mafic dykes south of the Woodroffe Thrust. The older event may reflect crustal thickening following the emplacement of thick (>5 km) mafic-ultramafic sills of the Giles Complex. Isotopic dating will have to be applied to establish the relationship between the younger event and the Late Proterozoic to Cambrian Woodroffe Thrust.

Mineralogical studies of the layered mafic/ultramafic Giles Complex and associated felsic granulites and granites of the western Musgrave Block provide an insight to the pressure–temperature–time evolution of the Musgrave Block. Goode & Moore (1975: Contributions to Mineralogy & Petrology, 51, 77–97) recorded P in the range of 1000–1200 MPa from mineral assemblages in some of the Giles Complex intrusions (e.g., Ewarara, Kalka, and Gosse Pile). These pressures were calculated from subsolidus reactions (1) ol + pl + cpx + sp = gnt, opx, and Ca-poor plg; (2) opx + plg to produce garnet (gnt); (3) sp + opx to produce garnet (gnt), and pl. Also, Ballhaus & Berry (1991: Contributions to Mineralogy & Petrology, 112, 1–28) have shown that the Wingellina Hills gabbronorite-pyroxenite body cooled isobarically from T = 1150 to 750°C under pressures of ca 650–620 MPa, based on the reaction of ol + plg to produce symplectites of opx–cpx–sp, ol–sp, and cpx–sp.

Recent thermobarometric measurements of mineral assemblages from samples collected as part of the National Geoscience Mapping Accord project in the Musgrave Block have produced the results documented below.

(1) Gnt–opx-bearing granulites from Mount Aloysius (Fig. 9) preserve coarse-grained mineral assemblages formed under moderately low pressures of ca 400 MPa (T = 750°C), an Rb–Sr isochron age of 1200 Ma for the granite metamorphism (Gray, 1978: Journal of the Geological Society of Australia, 25, 403–414) is correlated with D1 and D2 deformation (Clarke & others 1992: AGSO Research Newsletter, 17, 6–8). Core-to-rim zonation of garnet reflects subsequent cooling.

(2) Porphyritic hornblende (hbh)–biotite (bt) granitoids in the Tomkinson Ranges (western Musgrave Block) represent an 1185-Ma intrusive event (Sun & Sheraton, 1992: AGSO Research Newsletter, 17, 9–11) which either accompanied or closely followed emplacement of the Giles Complex. These rocks recrystallised to gnt–hbh greisses during the development of a mylonitic D3 foliation. These assemblages were formed at ca 1100 MPa (T = 650°C) — more than twice the pressure of the D1–2 granulate metamorphism.

(3) Coarse-grained gnt and opx in Mount Aloysius felsic granulites are surrounded by syn-

Fig. 10. Geological map of the mylonite zone, Bates 1:100 000 Sheet area (WA). Numbered ticks are 1 km intervals of the Australian Map Grid, Zone 52.
D3 to post-D3 gnt-cpx-plg symplectites, indicative
decompression to ca 450 Ma. This decompression is correlated with the formation of spinel-
cordierite coronas surrounding gnt in pelitic
gneisses at Cohn Hill, about 90 km west of Mount
Aloysius (Clarke & Powell, 1991: Journal of
Metamorphic Geology, 9, 440-451).

(4) Gnt-cpx assemblages occur within ultra-
lamolite zones which cut the granulate-facies
hanging block south of the south-dipping Wood-
roffe Thrust (see previous article). These assem-
bilages may predate, or are contemporary with, the
Woodroffe Thrust, which contains hydrous upper-
greenschist to upper-amphibolite-facies (biotite-
sericite ± amphibole) assemblages. The overlying
thrust-sheet also contains post-D3 mafic dykes
which recrystallised to gnt-cpx-hbl-plg-rutile-
quartz assemblages, and preserve mineral coronas
of metamorphic gnt-cpx-bearing symplectites
around magmatic opx and cpx grains (Fig. 11).

Thermobarometric measurements applied to the
recrystallised mafic dykes yields pressure esti-
mates of up to 1300 MPa (T = 700–750°C). These
PT estimates overlap the range between the upper-
mantle gnt-cpx granulate and the lowermost
eclogite fields (e.g., Holland, 1983: Contributions
to Mineralogy & Petrology, 82, 214-220), as re-
lected by the mole fraction of albite in plg (<0.77),
the jadeite content of cpx (<0.12), and the grossu-
lar content of gnt (<0.3). The gradational relation-
between these components as end-members of
solid solution in cpx and gnt complicates the defi-
nition of the above metamorphic fields. However,
the occurrence of rutile and scapolite in the post-
D3 dykes, which contrasts with the occurrence of
hematite in the syn-D3 granulates, is correlated
with group C eclogite-facies rocks elsewhere
(Coleman & others, 1965: Bulletin of the Geologi-
cal Society of America, 76, 483–508). Further, the
mineral assemblages and PT estimates correlate
with retrograde kyanite-bearing eclogite-facies
shear zones near Amata (Fig. 9), where P and T
were estimated as 1200 MPa and 850–900°C (El-
lis & Maboko, 1992: Precambrian Research, 55,
491-506).

The foregoing and earlier studies suggest that
the PT history of the western Musgrave Block
(Fig. 12) reflects (1) an increase in pressure from
the ca 1200-Ma D1-D2 metamorphism to the post-
1185-Ma D3 deformation; (2) late to post-D3 de-
compression; and (3) a sharp increase in pressure
after both D3 and the intrusion of mafic dykes. The
significant crustal thickening represented by the
late-D3 PT values, which correspond to lithostatic
pressures at depths of about 30 km, may be closely
related to the emplacement of the thick (>5 km)
dense mafic-ultramafic sills of the Giles Complex.
The post-D3 sharp increase in pressure may reflect
either: (1) that the granulates and mylonites south of
the Woodroffe Thrust represent basal structural
level in the overlying south-dipping thrust-sheet,
and originated in the crust at a depth of 30–40 km,
or (2) that the eclogite-facies assemblages were
developed in conjunction with Late Proterozoic
to Cambrian movements along the thrust.

The results of this investigation accord with the
observations of Goode & Moore (1975). Fur-
ther work is needed to determine the significance,
throughout the granulate-facies terrane, of PT vari-
ations suggested by others - for example, the
decrease in pressures south of the Hinkley Fault
(Nesbitt & others, 1970: Geological Society of
South Africa, Special Publication 1, 547-564) and
it is possible shallower crustal levels of the Black-
stone, Cavanagh, and Jameson gabbroic intrusions
to the west (Daniels, 1974: Geological Survey of
Western Australia, Bulletin 125; Ballhaus, 1992:
AGSO Research Newsletter, 16, 6–8).

For further information, contact Dr Geoff Clarke
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drew Gilkinson (Minerals & Land Use Program,
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Predicted changes of climate in the immediate
future, and their impact on human activities,
are causing widespread concern at government
and community level. The nature of future
climate changes, however, needs to be set in the
context of naturally occurring climatic cycles,
and the geological record provides a key source
of information on natural cycles on a variety of
timescales. The role of paleoclimatic
information is threefold: it provides the broad
context of naturally occurring change; it can be
used to test global-climate models; and, with
underscored qualification, it can provide
analogy for the predicted enhanced
greenhouse conditions of the future.

To fulfil these functions, information from the
recent geological past needs to be accessible in
formats suitable for manipulation in model tests.
A considerable body of proxy climatic data is
available for the Australian Quaternary — on lake
and sea levels, vegetation patterns, sea and land
temperatures, and hydrologic regimes. It is, how-
ever, currently widely scattered among individuals
and institutions.

AGSO’s Environmental Geoscience &
Groundwater Program and Information Systems
Branch are collaborating in the design of a data-
based to store and manipulate information about
climate in Australia during the Quaternary, which
covers the last 2 million years. The database will
run on the corporate Oracle relational-database
management system.

The climatic information is being extracted from
the published literature, which shows that the
Australian Quaternary mean annual temperatures
varied from a few degrees warmer to 8–10°C
colder than at present. Because climatic informa-
tion is extracted from a wide variety of disciplines,
the range of the database is correspondingly broad.
A bibliography (BMRC Record 1991/104), already
published (in hard-copy and digital forms), serves
as the source of the relevant information; at present
it holds 1300 references.

Besides atomic data, the database will store
series of tables - each relating to a different
branch of research: geochronology, geochemistry,
paleontology, palaeobotany, geomorphology, and
paleomagnetism. The third part contains the ‘con-
cclusions’ table, storing climatic inferences.

The database design is expected to benefit from
a small pilot scheme set up on Gumpie. Data are being entered into the four tables so far erected —
vertis, ‘sites’, ‘geochronology’, ‘geochemistry’,
and ‘conclusions’. The ‘conclusions’ table struc-
ture is very general at present, it will allow entry
of data and conclusions so as to gauge the types of fields
necessary in the final structure. Tables for ‘palaeo-
botany’ and ‘paleoontology’ are being developed
in collaboration with staff and students from the
Department of Geology, Australian National Uni-
versity.

We are keen for more interaction with the
Quaternary scientific community about the data-
based design and what information should be stored
in it. In the future it should become a place where
new research information is entered and unpub-
lished work stored. With ready external access
it could become a key resource for those national
and international researchers interested in the climatic
environment of the Australian Quaternary.

For further information, contact Geoff Hunt or Dr
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Groundwater Program, AGSO).