Unravelling the complexity of the Gascoyne Complex

by

S. Sheppard

The Gascoyne Complex is located at the western end of the presently exposed Proterozoic Capricorn Orogen, which includes numerous basins (Fig. 1) filled with low-grade metasedimentary rock and some mafic metavolcanic rock (Cawood and Tyler, in press). The orogen is widely considered to have formed during oblique collision of the Archaean Yilgarn and Pilbara Cratons during the 1830–1780 Ma Capricorn Orogeny (e.g. Tyler and Thorne, 1990; Powell and Horwitz, 1994; Krapez, 1999; Evans et al., 2003); however, views on the timing of rifting and convergence, and the polarity of subduction vary widely, in part because these models are based on interpretations of poorly dated metasedimentary successions in the northern part of the orogen. The ages of these successions are weakly constrained because they do not contain rocks suitable for the isotopic determination of depositional ages. In contrast, the medium- to high-grade metamorphic rocks and the intermediate to silicic igneous rocks of the Gascoyne Complex provide a nearly 400 million-year record of the tectonothermal evolution of the western part of the orogen.

The Gascoyne Complex comprises several terranes, each with a discrete geological history, bounded by large east-southeasterly trending faults or shear zones (Fig. 2). Each terrane is characterized by a metasedimentary package (or packages) together with granitic supersuites that differ in either age or composition, or both, from those

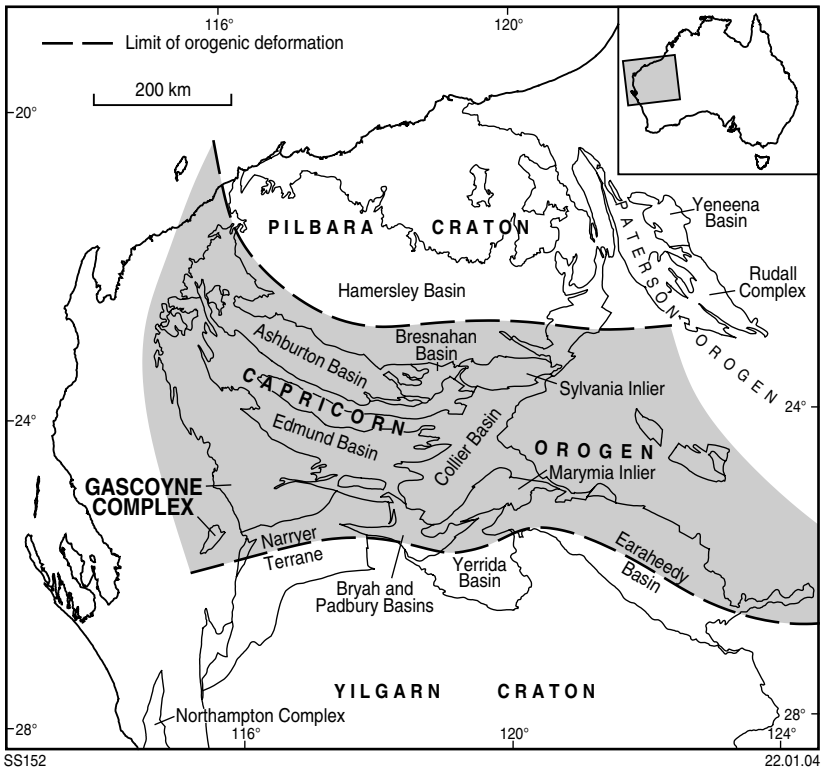

Figure 1. Location of the Capricorn Orogen and its constituent tectonic units

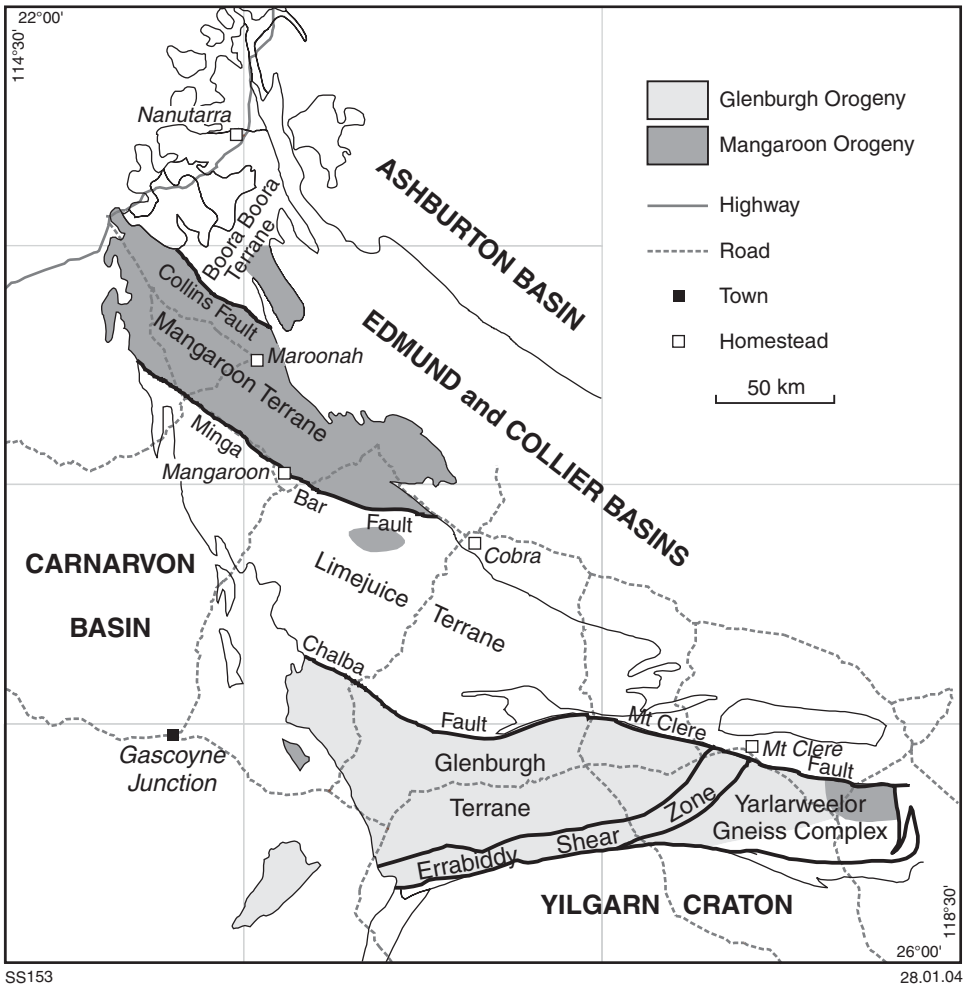

Figure 2. Subdivision of the Gascoyne Complex into terranes. The areal extent of the Glenburgh and Mangaroon Orogenies is also shown. The entire Gascyone Complex was affected by the Capricorn Orogeny

in adjacent terranes. The metamorphic and structural history of each terrane also contrasts with the histories of the terranes that bound it.

At the southern end of the complex, the Glenburgh Terrane consists of c. 2550 Ma granitic basement to a 2005–1970 Ma granitic batholith. This terrane is exotic to the Yilgarn Craton, but the relationship of the Glenburgh and Limejuice Terranes is unclear. The Limejuice Terrane is dominated by medium-grade metasedimentary rocks with protolith ages younger than 1840 Ma, which were intruded by granites with crystallization ages of c. 1785 and c. 1650 Ma (Varvell et al., 2003; Nelson, in prep.). The Boora Boora Terrane at the northern end of the complex has a similar geological history to the Limejuice Terrane, suggesting that this crust is contiguous underneath the Mangaroon Terrane.

Recent U–Pb sensitive high-resolution ion microprobe (SHRIMP) geochronological studies show that the Gascoyne Complex was primarily shaped by three separate orogenic events: the 2005–1970 Ma Glenburgh Orogeny, the 1830–1780 Ma Capricorn Orogeny, and the 1685–1650 Ma Mangaroon Orogeny. The effects of a fourth event (the Neoproterozoic Edmundian Orogeny) are mainly confined to fault and shear zone reactivation.

There are structures, metamorphic assemblages, and extensive granitic intrusions related to the Capricorn Orogeny across the whole Gascoyne Complex, whereas the other two orogenies have a more restricted distribution (Fig. 2). The Glenburgh Orogeny, which reflects the collision of the Glenburgh Terrane (or a combined Pilbara–Gascoyne craton) with the Yilgarn Craton, affected the Glenburgh Terrane and adjacent parts of the Yilgarn Craton (Occhipinti et al., in press; Sheppard et al., in press). Intracontinental reworking during the Mangaroon Orogeny is mainly confined to the Mangaroon Terrane in the north of the complex (Sheppard and Occhipinti, in prep.).

Within the Gascoyne Complex, only the Glenburgh Terrane contains evidence of a volcanic–plutonic arc, either of oceanic or continental affinity: this arc reflects subduction under the southern edge of the Glenburgh Terrane prior to amalgamation with the Yilgarn Craton at c. 1960 Ma (Sheppard et al., in press). Nowhere in the terranes of the Gascoyne Complex are igneous rocks

present that could be interpreted as a convergent margin that evolved before a postulated continent–continent collision during the Capricorn Orogeny. Indeed, there are no rocks with depositional or crystallization ages between c. 1960 and c. 1840 Ma. The paucity or absence of volcanic rocks does not reflect the current level of exposure, because metasedimentary rocks are abundant throughout the complex.

Granitic rocks intruded during the Capricorn Orogeny are either silicic I-types formed by remelting of older crust, or S-types. These compositions, and the lack of associated gabbros, distinguish the granites from batholiths formed at Andean-type margins and at island arcs. Therefore, it is very unlikely that granites intruded during the Capricorn Orogeny reflect subduction of oceanic crust. The 'Capricorn' granites in the Gascoyne Complex have broad similarities with Phanerozoic granites interpreted to have formed in post-collisional settings (e.g. Hercynides, Caledonides, Lachlan Fold Belt: Sylvester, 1998); however, the Gascoyne Complex, unlike these Phanerozoic orogens, apparently has no prior convergent margin activity.

If there was no subduction prior to, and during, the Capricorn Orogeny, then the Yilgarn and Pilbara Cratons must have been more or less in their current relative positions (other than probable dextral strike-slip movement during the Capricorn Orogeny: Tyler and Thorne, 1990; Occhipinti et al., 1998; Evans et al., 2003). A corollary of this conclusion is that the Capricorn Orogeny was probably intracratonic. If this is correct, then the earlier Glenburgh Orogeny, rather than marking accretion of a microcontinent to the Yilgarn as Sheppard et al. (in press) suggest, may record collision of a combined Pilbara–Gascoyne ('Pilboyne') Craton with the Yilgarn Craton. Ongoing mapping and associated geochronological, structural, metamorphic, and geochemical studies in the Gascoyne Complex will continue to test various tectonic models.

References

CAWOOD, P. A., and TYLER, I. M., in press, Assembling and reactivating the Proterozoic Capricorn Orogen: lithotectonic elements, orogenies, and significance: Precambrian Research.

EVANS, D. A. D., SIRCOMBE, K. N., WINGATE, M. T. D., DOYLE, M. G., MCCARTHY, M., PIDGEON, R. T., and VAN NIEKERK, H. S., 2003, Revised geochronology of magmatism in the western Capricorn Orogen at 1805–1785 Ma: Diachroneity of the Pilbara–Yilgarn collision: Australian Journal of Earth Sciences, v. 50, p. 853–864.

KRAPEZ, B., 1999, Stratigraphic record of an Atlantic-type global tectonic cycle in the Palaeoproterozoic Ashburton Province of Western Australia: Australian Journal of Earth Sciences, v. 46, p. 71–87.

NELSON, D. R., in prep, Compilation of geochronology data 2003: Western Australia Geological Survey, Record 2004/2.

OCCHIPINTI, S. A., SHEPPARD, S., NELSON, D. R., MYERS, J. S., and TYLER, I. M., 1998, Syntectonic granite in the southern margin of the Palaeoproterozoic Capricorn Orogen, Western Australia: Australian Journal of Earth Sciences, v. 45, p. 509–512.

OCCHIPINTI, S. A., SHEPPARD, S., PASSCHIER, C., TYLER, I. M., and NELSON, D. R., in press, Palaeoproterozoic crustal accretion and collision in the southern Capricorn Orogen: The Glenburgh Orogeny: Precambrian Research.

POWELL, C. M., and HORWITZ, R. C., 1994, Late Archaean and Early Proterozoic tectonics and basin formation of the Hamersley Ranges: Geological Society of Australia (WA Division), 12th Australian Geological Convention, Perth, W.A., 1994, Excursion Guidebook no. 4, 53p.

SHEPPARD, S., and OCCHIPINTI, S. A., in prep., Intracontinental reworking in the Capricorn Orogen during the 1685–1660 Ma Mangaroon Orogeny: Australian Journal of Earth Sciences.

SHEPPARD, S., OCCHIPINTI, S. A., and TYLER, I. M., in press, A 2005–1970 Ma Andean-type batholith in the southern Gascoyne Complex, Western Australia: Precambrian Research.

SYLVESTER, P. J., 1998, Post-collisional strongly peraluminous granites: Lithos, v. 45, p. 29–44.

TYLER, I. M., and THORNE, A. M., 1990, The northern margin of the Capricorn Orogen, Western Australia — an example of an early Proterozoic collision zone: Journal of Structural Geology, v. 12, p. 685–701.

VARVELL, C. A., CULVER, K. E., and FITZSIMONS, I. C. W., 2003, Structure, metamorphism and SHRIMP U–Pb geochronology of the central Gascoyne Complex, Western Australia *in* SGTSG Field Meeting, *edited by* S. REDDY, I. C. W. FITZSIMONS, and A. S. COLLINS: Geological Society of Australia, Abstracts 72, Kalbarri, p. 56.