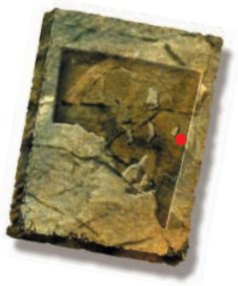

Definition of major sedimentary and igneous units of the Olary Domain, Curnamona Province

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Introduction

The Curnamona Province, which spans the SA–NSW border, contains the world's largest known Pb–Zn–Ag deposit at Broken Hill, and tantalising gold and base metal mineralisation is now being revealed in other parts of the province (see Teale, this issue). The Willyama Supergroup (Willis *et al.*, 1983), which comprises the basement to the province, has recently been considered in three parts, based on geochronological investigations by Page *et al.* (2000):

upper — ~1.64 Ga, equivalent in time to the Mount Isa and HYC deposit sequences of northern Australia

middle — ~1.69 Ga, including the Broken Hill deposit

lower — ~1.71 Ga, containing the bulk of the Cu–Au mineralisation of the southern Curnamona Province.

Moreover, it is now known that two very different styles of magmatism were synchronous with deposition of the lower and middle parts of the Willyama Supergroup, and tuffaceous sediments in the upper suggest a third.

The purpose of this article is to introduce a formal lithostratigraphic scheme for major subdivisions of the Olary Domain (OLD), and comparison of these subdivisions to those of the Broken Hill Domain (BHD), the two major components of the Curnamona Province. This formal scheme will be of value to geologists working in the OLD, who have previously had to rely on various useful but informal schemes.

This formal scheme is based largely on 'tried and true' pre-existing work (e.g. Campana, 1953; Flint and Flint, 1975; the work of Carpentaria Exploration Company (CEC) and Esso Minerals from 1968 to 1980 (Carpentaria Exploration Co. Pty Ltd, Esso Minerals and Aberfoyle Resources Ltd, 1968; Esso 1979 annual report); and Clarke *et al.*, 1986). Where possible, stratigraphic names have been retained or adapted from pre-existing work.

Definitions

Eleven units at formation level were proposed by Conor (2000) at the May 2000 Broken Hill Exploration Initiative (BHEI) Conference in Broken Hill; these, together with other formations and members, will be formalised in the near future after type sections have been evaluated. One well-known unit, the 'Bimba formation' (Esso, 1979 annual report), although not formally defined, will be referred to in this paper. Work is in progress to formally define this lithologically variable unit and determine the most suitable type section. Laing (1996a) restricted the name 'Bimba' to sulphidic parts of the unit, which he named the 'Bimba sulphide member'. Lithostratigraphic names which are the subject of this paper are shown in Table 1 (Willyama Supergroup) and Table 2 (igneous suites). Table 1 also broadly compares this lithostratigraphic scheme to that of the BHD; the reader is referred to Willis *et al.* (1983) and Stevens *et al.* (1983) for further information on this domain.

Most of the group and subgroup level units herein are defined with representative traverses or areas (Figs 1, 3, 4) in lieu of type sections, pending publication of the definitions of constituent units (Conor, 2000).

The recent geochronological information of Page *et al.* (1998, 2000), and relationship of igneous rocks to the enclosing Palaeoproterozoic metasediments, represent important constraints on stratigraphic subdivision of the Willyama Supergroup in the OLD (Fig. 2).

Volcanics of the Abminga Subsuite (Basso Suite) are synchronous with

Table 1 *New lithostratigraphic units for the Willyama Supergroup, OLD, and comparison with previous unit names and units of the BHD.*

U–Pb (Ga)	New units	Suites of Clarke *et al.* (1986)	Broken Hill groups
	Strathearn Group	pelite	
1.65	Mount Howden Subgroup		Paragon
1.69	Saltbush Subgroup		Broken Hill and Sundown
	Curnamona Group		
1.71	Ethiudna Subgroup	Bimba and calcsilicate	Broken Hill
1.71	Wiperaminga Subgroup	quartzofeldspathic and composite gneiss	Thackaringa and below

Table 2 *New lithostratigraphic units for the older igneous suites of the OLD and possible correlatives in the BHD.*

U–Pb (Ga)	New suite names (Olary)	Broken Hill (approximate correlatives)
1.69	**Lady Louise Suite**	Parnell Formation and amphibolites, Rasp Ridge Gneiss
	Basso Suite	
1.71	Abminga Subsuite	
1.71	Ameroo Subsuite	Alma Gneiss

U–Pb determinations of Lady Louise Suite from C.M. Fanning (ANU, pers comm., 1998), and Basso Suite from Page *et al.* (2000).

deposition of the Curnamona Group, being present in both the Wiperaminga and Ethiudna Subgroups. Amphibolites of the Lady Louise Suite are later than, and intrude, both the Curnamona Group and Basso Suite but, except in one possible instance at its base, are not observed in the Strathearn Group.

Curnamona Group

Derivation of name: 'Curnamona' Station, 100 km northwest of Olary, SA. Adapted from CEC and Esso terminology (1968–80).

Representative traverse: Cathedral Rock area, 'Old Boolcoomata', near Olary (Figs 1, 3); from Old Bulloo Creek Dam (0440970 mE, 6444730 mN) westwards (towards the Mount Mulga barite mine) to 0437620 mE, 6445180 mN, then northwestwards (towards Cathedral Rock, 0435800 mE, 6449340 mN) to 435970 mE, 6448980 mN (all coordinates are relative to GDA 94, Zone 54).

Distribution: The Curnamona Group dominates the southern portion of the OLD (Fig. 1).

Age: ~1.71 Ga, Palaeoproterozoic, from intercalated metavolcanics (Abminga Subsuite, see below) and related volcaniclastic metasediments.

Description: Metasediment-dominated, volcano-sedimentary sequence (for more detail see Ethiudna and Wiperaminga Subgroups below).

Relationship: Lower part of the Willyama Supergroup. Base not observed. Topmost unit underlies graphitic basal psammopelite of the Strathearn Group. Generally equivalent to all units including and below the Ettlewood Calcsilicate Member of the Broken Hill Group of the BHD.

Remarks: Generally albite and magnetite altered. Characterised by the presence of Abminga Subsuite volcanics and intrusive parts of the Lady Louise Suite.

Synonym: Incorporates the Bimba, calcsilicate, quartzofeldspathic and composite gneiss suites of Clarke *et al.* (1986).

Wiperaminga Subgroup

Derivation of name: Modified from the 'Wiperaminga group' of CEC and Esso Minerals, after Wiperaminga Hill (Fig. 1).

Representative traverse: Cathedral Rock area, 'Old Boolcoomata', near Olary, SA (Figs 1, 3); see portion of Curnamona Group representative traverse, i.e. Old Bulloo Creek Dam, 0440970 mE, 6444730 mN northwestwards to 0436100 mE, 6448640 mN.

Distribution: Widespread and dominating the southern part of the OLD.

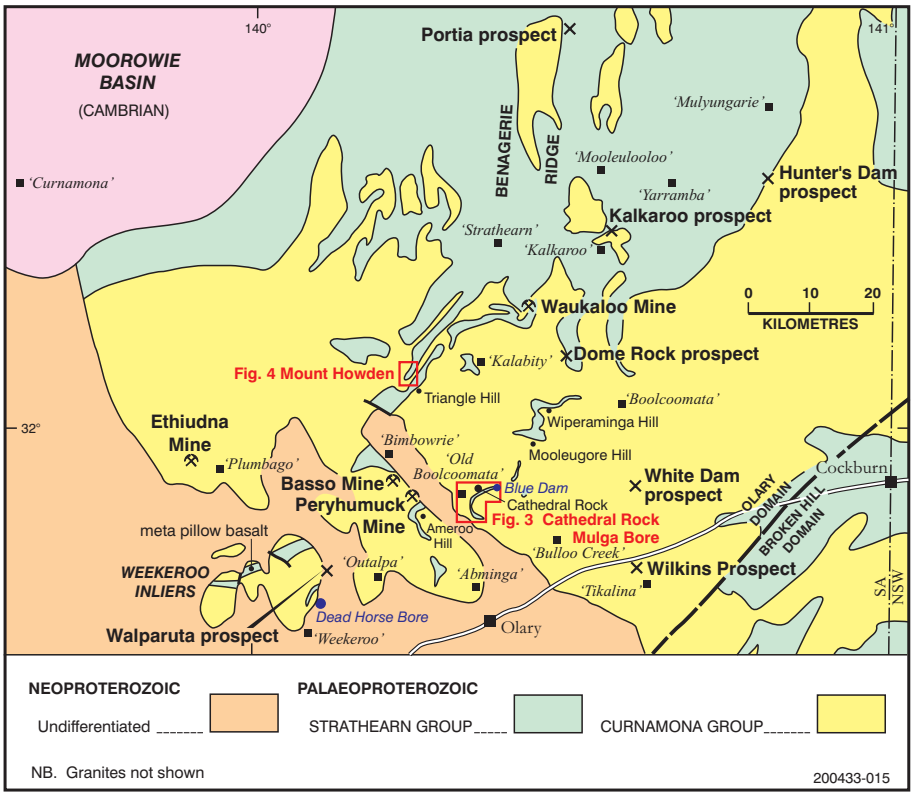

Fig. 1 *Location diagram and general solid geology, OLD.*

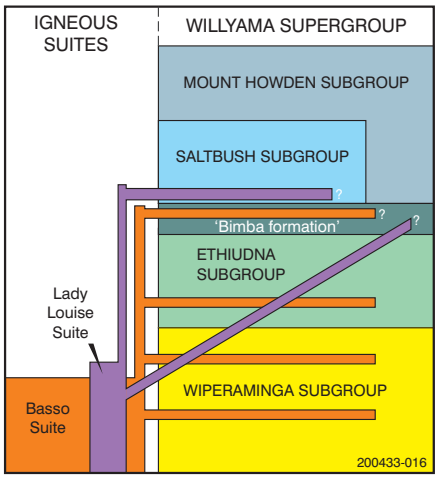

Fig. 2 *Relationship of Willyama Supergroup and contemporary igneous suites, OLD.*

Age: 1.71 Ga (e.g. 1715 3 and 1712 2 Ma; Page *et al.*, 2000, from intercalated Abminga Subsuite, and related tuffaceous metasediments).

Description: Dominated by interlayered albitised and schistose metasediments. Locally thickly layered quartz albitites are equated with the Abminga Subsuite ('lower albite' of CEC and Esso Minerals); these are variably aphyric, quartz-eye, pyrite and magnetite bearing. All albitic units are oxidised and generally magnetite bearing. Large, planar-layered, flaggy psammopelitic units occur locally which, in the Mount Howden – Mooleugore Hill area, dominate over albitic units. There are occasional iron formations, some of which are baritic. A schistose unit is commonly found near the top of the Wiperaminga Subgroup; this is the 'middle schist' of CEC and Esso. In several places (e.g. eastern Weekeroo Inliers, Ameroo Hill and near Cathedral Rock), quartzites increase in the upper part of the sequence, and may even form the topmost unit. Some of these quartzites are magnetite rich and locally barite rich.

Relationship: The Wiperaminga Subgroup, which underlies the Ethiudna Subgroup, is the lowermost unit of the Willyama Supergroup in the OLD; no base has yet been discovered. It is equivalent to the Thackaringa Group, Thorndale Composite Gneiss and Clevedale Migmatite of the BHD.

Remarks: The increasing frequency of quartzite in the upper part of the Wiperaminga Subgroup, together with the incoming of calcsilicate minerals in the overlying Ethiudna Subgroup,

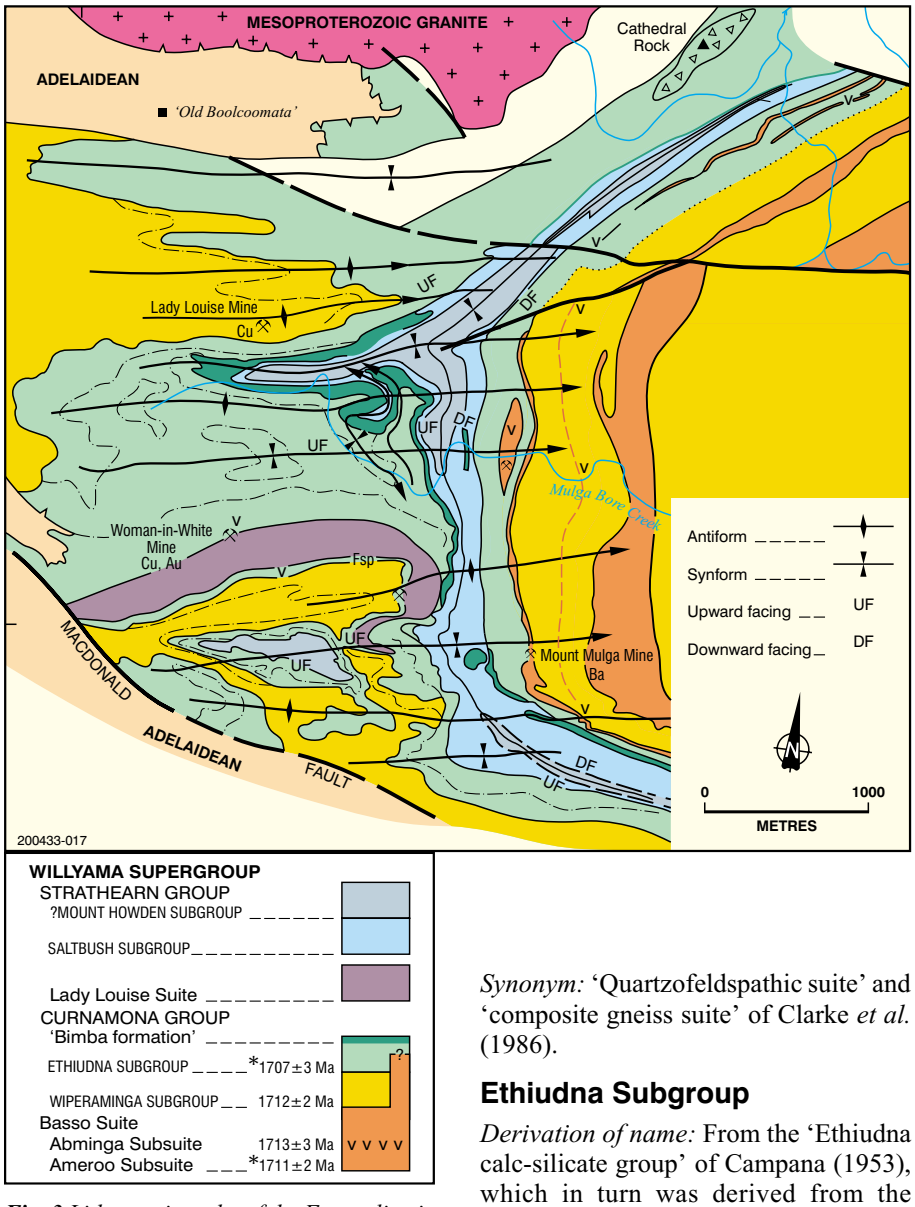

Fig. 3 *Lithostratigraphy of the F_1 syncline in the Cathedral Rock – Mount Mulga area, OLD (Dates*: R.W. Page, pers. Comm., Consultant, 2000).*

suggest an extensive change in basin evolution. However, Abminga Subsuite 'volcanics' are intercalated with both the Wiperaminga and Ethiudna Subgroups, suggesting that there was no significant time break between deposition of the subgroups. The Wiperaminga Subgroup is commonly migmatitic, and it is possible that this style of alteration increases downwards. Ironstones within the Wiperaminga Subgroup are Cu–Au mineralised (e.g. Wilkins prospect). A regionally important zone (Leyh and Conor, 2000), which contains the majority of Cu–Au occurrences in the region, is located in the upper part of the Wiperaminga Subgroup and in the overlying Ethiudna Subgroup.

Synonym: 'Quartzofeldspathic suite' and 'composite gneiss suite' of Clarke *et al.* (1986).

Ethiudna Subgroup

Derivation of name: From the 'Ethiudna calc-silicate group' of Campana (1953), which in turn was derived from the Ethiudna Mine on 'Plumbago'.

Representative traverse: Southeastern limb of a syncline near Mount Howden, 'Bimbowrie', near Olary, SA (Figs 1, 4). From 0424550 mE, 6466650 mN northwestwards to 0424380 mE, 6466820 mN.

Subsidiary location for upper unit of the Ethiudna Subgroup (i.e. 'Bimba formation'), Mount Howden Cobalt Mine, 0424040 mE, 6467440 mN.

Subsidiary location for fine-grained albitic metasediments ('upper albite' of CEC and Esso Minerals) from Curnamona Group traverse south of Cathedral Rock (Fig. 3): 0436100 mE, 6448640 mN to 435970 mE, 6448980 mN.

Distribution: Widespread unit across the OLD.

Age: ~1.71 Ga from contained felsic volcanics, proximal epiclastics and tuffaceous metasediments (Abminga Subsuite, see below) in the lower part of the subgroup (e.g. 1712 2 Ma, Page *et al.*, 1998; 1717 3 Ma, Page *et al.*, 2000).

Description: Lithologically variable, but generally characterised by calcsilicate minerals in combination with albite. The uppermost part comprises the 'Bimba formation', and the lower the 'upper albite' (both of CEC and Esso Minerals).

The 'Bimba formation' is typified by variable quantities of marble or calc-silicate, and parts are pyritic; it also shows polymetallic anomalism.

The 'upper albite' is typified by fine-grained, finely laminated albitic metasediments which commonly show sedimentary structures such as flaser and cross-bedding, and pseudomorphs which are interpreted to be after diagenetic or evaporite minerals such as dolomite and gypsum. Other common lithologies within the subgroup include grey, fine-grained felsic schist and, in the southern part of the eastern Weekeroo inlier, coarse-grained quartzofeldspathic and pelitic schist. The rocks are locally manganiferous (e.g. piemontite, Mn garnet, Mn oxides) and, like the underlying Wiperaminga Subgroup, are generally sufficiently oxidised to be

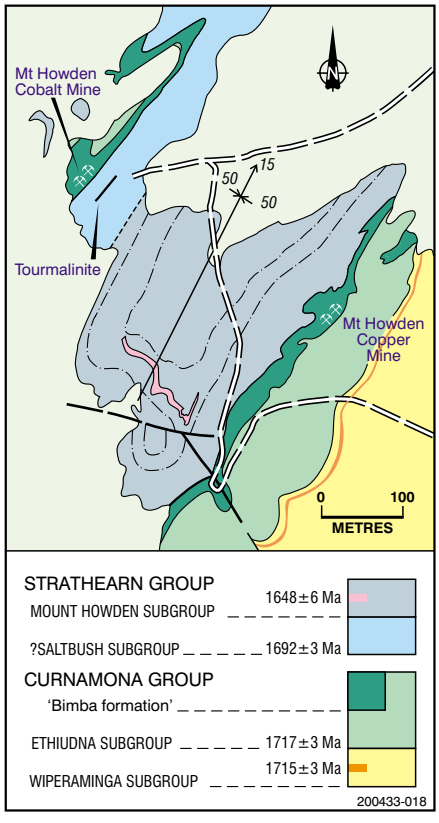

Fig. 4 *Lithostratigraphy of the Mount Howden area, OLD.*

magnetite or haematite bearing. Locally baritic.

Relationship: Overlies the Wiperaminga Subgroup, the top of which commonly shows development of quartzite. Like the Wiperaminga, the Ethiudna Subgroup contains Abminga Subsuite 'volcanics' (1.71 Ga).

Remarks: The 'Bimba formation' is sulphidic and generally has a low magnetic susceptibility, while the underlying unit is albitic and commonly has a high magnetic susceptibility. The Ethiudna Subgroup therefore contains a regional magnetic marker which has proved extremely useful to explorers in the covered areas of the OLD. Ethiudna Subgroup is the likely stratigraphic equivalent of the host unit to Cu–Au–Mo mineralisation at Kalkaroo and a group of prospects on the Benagerie Ridge (e.g. Portia prospect).

Synonym: 'Bimba suite' and 'calcsilicate suite' of Clarke *et al.* (1986); 'Bimba formation' and 'upper albite' of CEC and Esso Minerals.

Strathearn Group

Derivation of name: Informal term of CEC and Esso Minerals from 'Strathearn'.

Representative traverses: See Saltbush Subgroup and Mount Howden Subgroup.

Distribution: Widespread, especially in the northern, covered part of the OLD.

Age: ~1.69–<1.48 Ga (Page *et al.*, 1998, 2000; U–Pb, tuffaceous metasediments).

Description: Psammopelites and pelites, locally graphitic. Sillimanite bearing in the southern, higher metamorphic grade parts of the OLD.

Relationship: Overlies the Curnamona Group, and comprises the upper part of the Willyama Supergroup in the OLD. Top is not known, but is presumed to underlie Mesoproterozoic volcanics of the central Curnamona Province. Equated with the Broken Hill, Sundown and Paragon Groups of the BHD.

Remarks: Syngenetic Pb–Zn prospective.

Synonym: 'Pelite suite' of Clarke *et al.* (1986).

Saltbush Subgroup

Derivation of name: New name from Saltbush Dam on 'Abminga' (Fig. 1), near Olary, SA.

Representative traverse: On 'Weekeroo', 28 km west of Olary. Eastern Weekeroo Inliers, syncline near Dead Horse Bore (Fig. 1): 0409060 mE, 6433800 mN to 0409280 mE, 6433700 mN.

Distribution: Preserved in synclinal cores in the southern part of the OLD. Possibly extends under cover to the north.

Age: 1.69 Ga and younger; basal unit (see Conor, 2000, 'Plumbago formation') dated from detrital zircon population (Page *et al.*, 2000). A U–Pb age of 1692 3 Ma was obtained from a similar lithology at Mount Howden Cobalt Mine (Page *et al.*, 2000).

Description: Schistose, psammopelitic metasediments with thin, locally graded, psammite layers. Tourmaline is a common accessory, with minor tourmalinites. Mn-coticules and iron formations locally near the base (e.g. Blue Dam area; Ashley *et al.*, 1998).

The basal part is characteristically graphitic, grading downwards into fine-grained micaceous psammite.

Relationship: Overlies the Ethiudna Subgroup ('Bimba formation'). Possibly overlain by the Mount Howden Subgroup, a relationship unproven at present. Lithologically similar to the Freyers Metasediment and Sundown Group of the BHD, and contained iron formations are chemically similar to those of the Broken Hill Group. The Saltbush Subgroup is therefore tentatively equated with parts of the Broken Hill and Sundown Groups.

Remarks: Some potential for Pb–Zn mineralisation.

Synonym: Possibly 'Mustering Paddock Formation' (Laing, 1996a).

Mount Howden Subgroup

Derivation of name: From 'Mount Howden Formation' (Laing, 1996a). Mount Howden is on 'Bimbowrie', near Olary, SA.

Representative traverse: Syncline near Mount Howden (Figs 1, 4); 0424380 mE, 6466820 mN to 0424200 mE, 6467000 mN.

Distribution: Known from representative area, and possibly widespread in the northern covered part of the OLD.

Age: Timing is indicated by two U–Pb determinations: 1692 3 Ma age from an underlying unit (see above), and 1648 6 Ma from a detrital zircon population contained by a ?tuffaceous metasediment within the Mount Howden Subgroup (Page *et al.*, 1998).

Description: Psammopelitic metasediments, with lesser psammite and pelite. Possibly comprises three formations (Conor, 2000); the middle one, from which the above U–Pb date was obtained, is a thick albitic psammitic horizon. These formations will be defined in a later publication.

Relationship: Overlies the Ethiudna Subgroup and probably, where in juxtaposition, the Saltbush Subgroup. Equivalent to the Paragon Group of the BHD. The upper boundary has not been observed.

Remarks: The above age determination indicates a chronostratigraphic correlation with the Mount Isa Block (Page *et al.*, 2000), hence the potential for syngenetic Pb–Zn mineralisation.

Synonym: 'Mount Howden Formation' (Laing, 1996a).

Palaeoproterozoic igneous rocks

Lady Louise Suite

Derivation of name: Lady Louise Mine near 'Old Boolcoomata', near Olary, SA (Figs 1, 3).

Representative localities: Intrusive — amphibolite near the Woman-in-White Mine near 'Old Boolcoomata' (0432970 mE, 6446070 mN; Fig. 3). Extrusive — meta-pillow basalt in northern part of the Weekeroo Inliers on 'Weekeroo' (399500 mE, 6437200 mN).

Distribution: Widespread as sills and dykes throughout the OLD, but restricted to the Curnamona Group and perhaps the lowermost part of the Strathearn Group. It is presumed that the type amphibolite near the Woman-in-White Mine is related to common, thin, dyke-like sills, rarer larger lenticular masses, and the above-mentioned meta-pillow basalt on 'Weekeroo'.

Age: 1.69 Ga, from dating of the type amphibolite (C.M. Fanning, ANU, pers. comm., 1998; Conor, 2000); to be discussed in detail by Conor and Fanning (in prep.).

Description: The type amphibolite near the Woman-in-White Mine (Constable, 1999) is a differentiated lenticular body varying from a high FeO, high MgO melanocratic quartz-bearing amphibolite to a mesocratic hornblende granite; the mafic component is dominant.

Elsewhere, a characteristic of sills equated with the Lady Louise Suite is the degree of metamorphism. Foliated, lineated and metamorphically layered fabrics are common. In the Mutooroo area, where the metamorphic grade is highest in the Olary region, the amphibolites are hypersthene bearing.

Relationships: Intrusive into the Curnamona Group, including the Basso Suite. The stratigraphic position of the extrusive metabasalt in the Weekeroo Inliers is uncertain, but may be in the upper part of the Curnamona Group or lowermost part of the Strathearn Group. Disrupted by high strain zones of the 'Morialpa Migmatite' (Laing, 1996a). Deformed, and locally folded by at least F_3 (terminology of Berry *et al.*, 1978).

Remarks: The Lady Louise Suite incorporates all mafic, and genetically related felsic igneous rocks, which pre-date the ~1600 Ma Olarian Orogeny. Elements of the suite intrude units as young as the Ethiudna Subgroup, but have not yet been observed in the Saltbush or Mount Howden Subgroups. This suggests that the metabasalt near 'Weekeroo' may be in the stratigraphic vicinity of the Curnamona – Strathearn Groups boundary.

Amphibolites of the Lady Louise Suite are tentatively equated with the high FeO amphibolites of the Broken Hill and Thackaringa Groups of the BHD (Stephens, 1983); this statement is in keeping with the ideas of Laing (1996a), who equated the metabasalt near 'Weekeroo' with the Parnell Formation. In the BHD, it is now known that there is at least a temporal relationship between the Parnell Formation-type amphibolites and felsic intrusives, and effusive units such as the Rasp Ridge Gneiss (1682 3 Ma) and Hores Gneiss (1686 3 Ma; Page *et al.*, 2000).

Synonym: On OLARY 1:250 000 map; P_2 and P_3 of the 'Weekeroo' and 'Mutooroo' areas, respectively. Some representatives have been informally named (e.g. Weekeroo Amphibolite, Weekeroo-type, Mutooroo-type and Ameroo-type amphibolites; Flint and Parker, 1993).

Typical red-brown weathering of volcaniclastic metasediments of the Basso Suite at Mulga Bore, 'Bimbowrie'. (Photo 47611)

Tuffaceous metasediment near the top of the Mount Howden Subgroup, Mount Howden. (Photo 47613)

Northeasterly view towards Benagerie Ridge (under cover in the far distance) from Tonga Hill. (Photo 47612)

Basso Suite

Derivation of name: Basso Mine, 5 km south-southeast of 'Bimbowrie', near Olary, SA (Fig. 1). Name adapted from Benton (1994).

Representative localities: See Ameroo and Abminga Subsuites.

Distribution: Throughout much of the OLD, especially the southern part.

Description: Albitic granofels and granite gneiss; derived from felsic volcanic and granite protolith described as A-type in character (Ashley *et al.*, 1996), but generally sodium altered.

Relationship: Characterises the lower part of the Willyama Supergroup (i.e. Curnamona Group; see this paper). For detail see Ameroo and Abminga Subsuites.

Remarks: The Basso Suite includes the Ameroo Subsuite (metagranite, previously named Basso Granodiorite (Benton, 1994), and Ameroo Gneiss (Laing, 1996a)), and Abminga Subsuite (metavolcanics).

Synonym: None known.

Ameroo Subsuite

Derivation of name: Ameroo Hill, 12 km northeast of 'Outalpa', near Olary, SA. Derived from the 'Ameroo Gneiss' (Laing, 1996a).

Type locality: Ameroo Hill, 0425620 mE, 6445180 mN (Figs 1, 3).

Distribution: Throughout much of the OLD. Other examples occur in the Weekeroo Inliers, and near the Basso, Peryhumuck and Waukaloo Mines, Mulga Bore and Triangle Hill.

Age: ~1.71 Ga, for example 1703 6 Ma (Ashley *et al.*, 1994) for the body at Ameroo Hill, and 1711 2 Ma (Page *et al.*, 1998) for the Drew Hill – Mount Mulga body near 'Old Boolcoomata'. Zircon populations are simple, with little or no inheritance.

Description: The following description is from Laing (1996a): 'Variously described as a metagranitoid, massive felsic rock locally foliated, biotite gneiss, and adamellite gneiss. The metagranitoid of Ashley *et al.* (1994) in the type area is described as having A-type granite affinities. Other large but lenticular granitoid bodies in the same stratigraphic position are generally strongly foliated,…'. Quartz-eye texture is locally developed at margins.

Relationship: Bodies are generally conformable within the enclosing metasediments (i.e. sill like). Intruded by Mesoproterozoic granites and, south from Cathedral Rock, by amphibolites which are tentatively equated with the Lady Louise Suite.

Remarks: The Ameroo Subsuite represents intrusive (where determinable) members of the Basso Suite (see this paper).

Synonym: 'Basso Granodiorite' (Benton, 1994).

Abminga Subsuite

Derivation of name: From discovery locality at 429800 mE, 6437640 mN

(Buckley, 1993) on 'Abminga' (Fig. 1), near Olary, SA.

Type locality: Oonatra Creek, 1 km north of Old Sampson Dam on 'Bulloo Creek', 0446200 mE, 6452250 mN (Pepper and Ashley, 1998).

Distribution: Widespread throughout the OLD; other examples are present in the syncline near Dead Horse Bore (eastern Weekeroo Inliers), and near 'Old Boolcoomata' – Mulga Bore Creek and the creek south from Cathedral Rock (Fig. 3).

Age: ~1.71 Ga. An extensive U–Pb data set is available; examples are 1699 10 Ma from the 'Abminga' locality (Ashley *et al.*, 1996), and 1712 2 Ma from Mulga Bore Creek (Page *et al.*, 1998).

Description: Typically red-brown weathering, light brown, magnetite and pyrite-bearing, quartz-eye phyric, albitic, felsic metamorphosed rocks. Locally feldspar phyric, but commonly aphyric. Massive, flecky textured to layered. Where less metamorphosed, the groundmass is very fine grained. Magnetite is generally disseminated but commonly is redistributed in veins.

Relationships: Interlayered with metasediments of the Curnamona Group (see below). One example from the Mulga Bore Creek is Cu–Au mineralised (Ashley *et al.*, 1998). Commonly genetically associated with small iron formations (e.g. Pepper and Ashley, 1998). Sometimes spatially related to iron and barite-rich assemblages and associated Cu–Au mineralisation (e.g. Mount Mulga barite mine and Walparuta prospect).

Remarks: Members of the Abminga Subsuite are chemically and radiometrically equated with metagranites of the Ameroo Subsuite. Present evidence indicates that they represent subvolcanic sills, water-lain pyroclastic flows, and proximal pyroclastic and epiclastic sediments. Metasediments are also known (e.g. Mount Howden; Page *et al.*, 2000), which have a high zircon component consistent with a proximal Basso Suite source.

Synonym: Shown as 'Plm_1' on geological maps of the Universities of New England and Melbourne, and on the 1:100 000 Olary special map (Laing, 1996b).

For further information contact Colin Conor (ph. 08 8463 3061).

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