# Ediacaran stratigraphic correlations in the western Amadeus Basin, central Australia

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Field mapping by the Northern Territory Geological Survey (NTGS) during 2019 in LAKE AMADEUS[3] and BLOODS RANGE in the western Amadeus Basin followed on from previous mapping in HENBURY (2015–2017) in the central part of the basin (**Figure 1**). Specific goals of the overall central and western Amadeus Basin mapping program included refining the Neoproterozoic stratigraphy of the basin (eg Donnellan and Normington 2017) and integrating field observations into a new basin-wide solid geology and structural synthesis (Weisheit in prep).

Variable stratigraphic nomenclature has historically been used in describing Neoproterozoic sediments of the eastern versus the central and western Amadeus Basin (eg Wells *et al* 1963, Wells *et al* 1970, Preiss *et al* 1978). In the more extensively described eastern part of the basin, the major lithostratigraphic units of the Neoproterozoic succession are (in ascending order) the Tonian Heavitree Formation, Bitter Springs Group, and Wallara Formation; the Cryogenian Areyonga Formation, Aralka Formation, and Olympic Formation/Pioneer Sandstone; and the Ediacaran Olympic cap, Pertatataka Formation, Julie Formation, and lower Arumbera Sandstone. Correlative strata in the central and western Amadeus Basin have been referred to as the Tonian Dean Quartzite and Pinyinna beds, as well as the overlying Inindia beds and Winnall beds, the age ranges of which were uncertain but are now thought to cumulatively span from Tonian to early Cambrian. A major focus of mapping in the central and western part of the Amadeus Basin has been to replace informal Neoproterozoic stratigraphic units (eg Inindia beds, Winnall beds) with a formal and well-described lithostratigraphy.

HENBURY has proven to be a key region for correlation of Neoproterozoic strata between the eastern and western Amadeus Basin (Donnellan and Normington 2017). Recent NTGS mapping in this mapsheet area has revealed that strata originally mapped as Inindia beds (Ranford *et al* 1963) correspond with the Tonian Johnnys Creek, Loves Creek and Wallara formations, the early to middle Cryogenian Areyonga and Aralka formations (Preiss *et al* 1978, Allen *et al* 2018), and the late Cryogenian Pioneer Sandstone of the eastern Amadeus Basin succession (Normington *et al* 2019). In addition, the former Winnall beds on HENBURY (Ranford *et al* 1963) have been subdivided into five formations (Breaden, Gloaming, Froud, Liddle and Puna Kura Kura) that comprise the newly defined Winnall Group (**Figure 2**; Donnellan and Normington 2017). The lower parts of the group (Breaden, Gloaming and Froud formations) are predominantly in the central and eastern part of HENBURY; the overlying Liddle Formation occurs in the central and southwest part; and the uppermost unit (the Puna

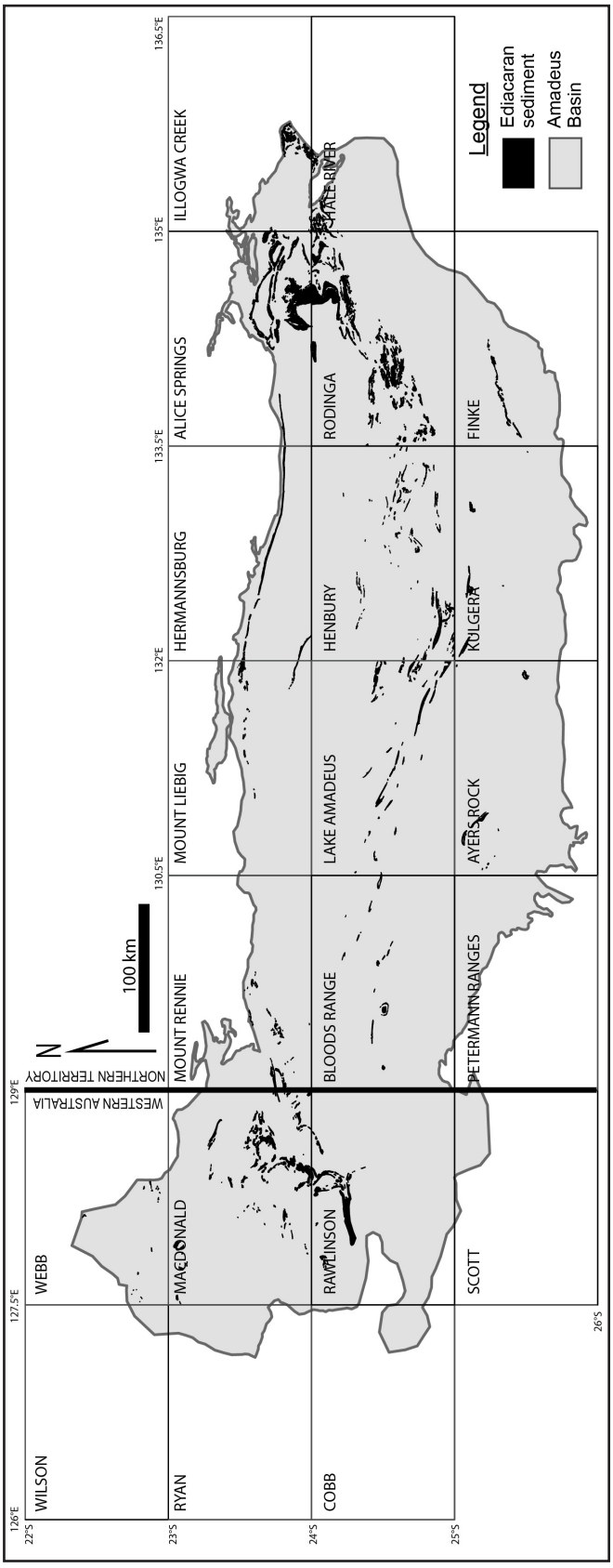


**Figure 1**. Distribution of Ediacaran strata (shown in black) in the Amadeus Basin (grey) of central Australia.

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[3] Names of 1:250 000 mapsheets are shown in capital letters, eg LAKE AMADEUS

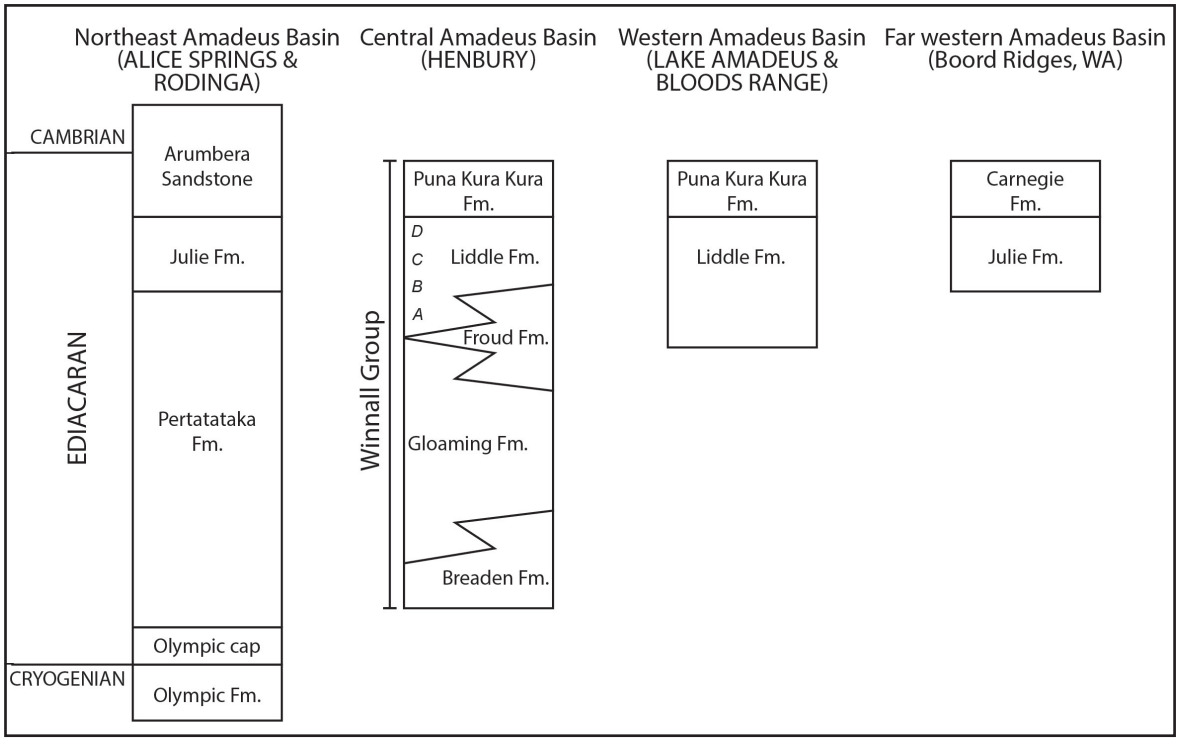


**Figure 2**. Ediacaran stratigraphic correlations in the Amadeus Basin (after Donnellan and Normington 2017, Normington *et al* 2019). Italicised letters in the Liddle Formation refer to informal lithofacies designations at its type locality in the Liddle Hills of HENBURY (Donnellan and Normington 2017).

Kura Kura Formation) occurs only in the southwest corner of HENBURY. The Ediacaran to potentially early Cambrian Winnall Group corresponds, in some fashion, with the Pertatataka Formation, Julie Formation and lower Arumbera Sandstone of the eastern Amadeus Basin (**Figure 2**).

As with the first edition HENBURY, the first editions LAKE AMADEUS and BLOODS RANGE depict small, isolated exposures of Inindia beds. Unlike the coherent Inindia beds stratigraphy of HENBURY that is correlative with the eastern Amadeus Basin (Donnellan and Normington 2017), Inindia beds mapped in LAKE AMADEUS and BLOODS RANGE consist predominantly of silicified, ferruginised, highly weathered and frequently brecciated rocks that are not recognisable as any particular part of the Neoproterozoic Amadeus Basin stratigraphy, although they seem, in general, to underlie the Winnall Group.

Mapping on LAKE AMADEUS and BLOODS RANGE has revealed that the upper units of the Ediacaran nomenclature formalised in southwest HENBURY extend across the western Amadeus Basin (**Figure 2**). Most areas formerly mapped as Winnall beds (Forman 1963, Wells *et al* 1963) comprise sandstone that is readily identifiable as Liddle Formation. Liddle Formation crops out as isolated strike ridges across the region, including at some prominent locations such as Winnall Ridge (**Figure 3a**; LAKE AMADEUS) and Souths Range (**Figure 3b**; BLOODS RANGE). At its type locality in the Liddle Hills of southwest HENBURY, Liddle Formation has been divided into a series of four informal lithofacies (**Figure 2**; Donnellan and Normington 2017). These lithofacies are also recognisable in LAKE AMADEUS and BLOODS RANGE, although few of the isolated exposures of Liddle Formation in the western Amadeus Basin preserve a complete succession as at the Liddle Hills. One lithofacies comprising sandstone with well-developed festoon cross-stratification (**Figure 3c**) is a relatively distinctive marker horizon that is useful for distinguishing the upper and lower parts of the Liddle Formation (**Figure 2**; Donnellan and Normington 2017). The most complete exposures of Liddle Formation in LAKE AMADEUS and BLOODS RANGE are roughly 500 m thick. The uppermost unit of Winnall Group (red, feldspathic sandstone of the Puna Kura Kura Formation; **Figure 3d**) is exposed in only a few isolated localities in LAKE AMADEUS. Ediacaran units that underlie the Liddle Formation in HENBURY (Breaden, Gloaming and Froud formations; **Figure 2**) do not extend into the western basin, consistent with their distribution primarily in central and eastern HENBURY.

The details of late Ediacaran–Cambrian stratigraphic correlations across the Amadeus Basin have been the subject of interest in recent years, particularly given significant stratigraphic revisions in both Northern Territory and Western Australia (eg Haines and Allen 2014, Donnellan and Normington 2017). One potential correlation is between lower Arumbera Sandstone in the eastern Amadeus Basin, Puna Kura Kura Formation in the central and western parts of the basin, and Carnegie Formation in far western areas (including the Western Australia portion of the basin; **Figure 2**; Haines and Allen 2014, Edgoose *et al* 2018, Normington *et al* 2019). Detrital zircon results from all three formations are permissive of late Ediacaran deposition (Buick *et al* 2005, Maidment *et al* 2007, Haines *et al* 2016, Normington *et al* 2018). Arumbera Sandstone and Carnegie Formation overlie the Julie Formation in the eastern and portions of the far western Amadeus Basin respectively, but Julie Formation is absent in the central and western basin,

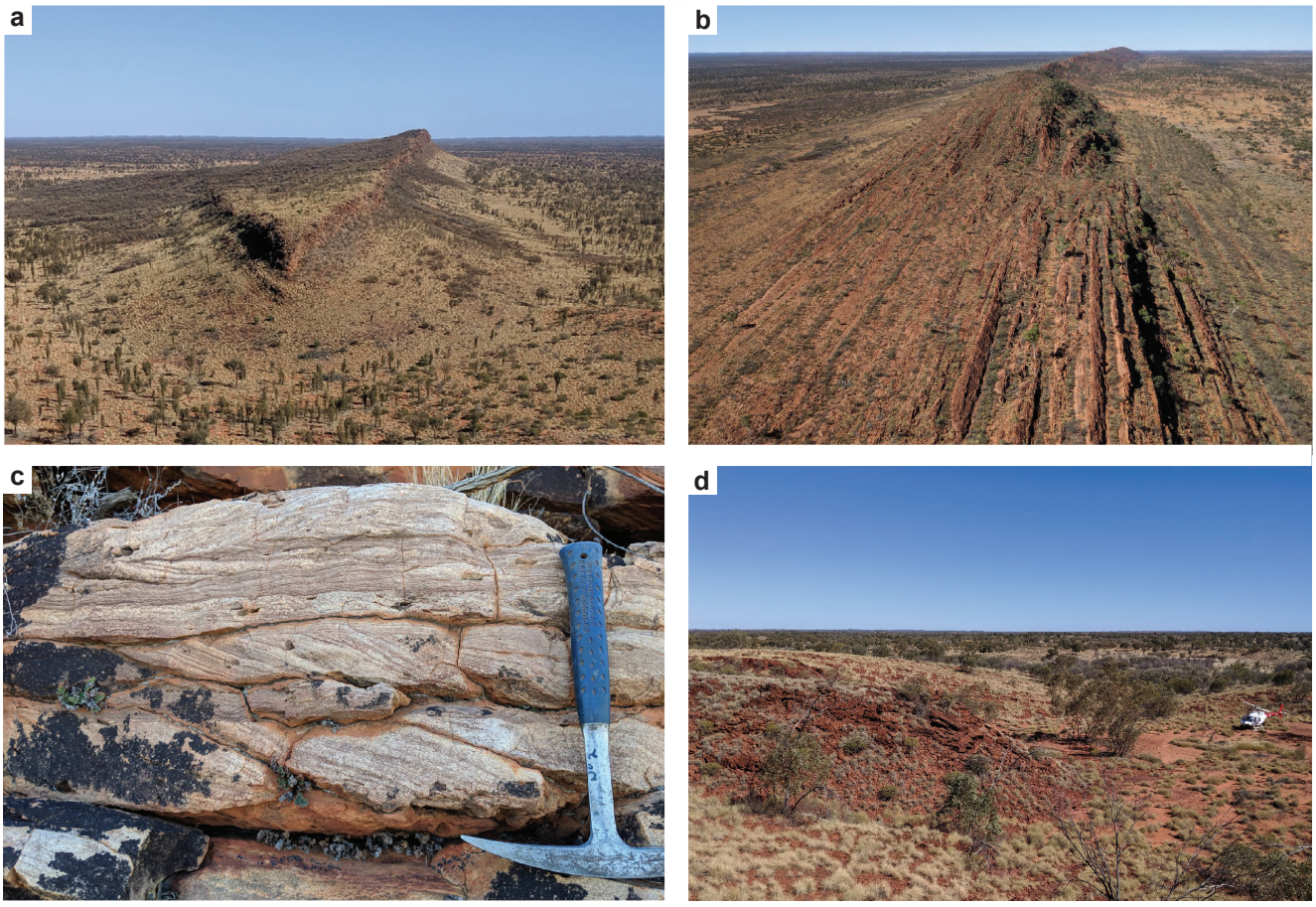


**Figure 3**. Ediacaran to potentially early Cambrian sandstone in the western Amadeus Basin. (**a**) Syncline of lower Liddle Formation sandstone at Winnall Ridge (LAKE AMADEUS). In the foreground the top of the ridge is approximately 20 m above the surrounding area. (**b**) Along-strike view of lower Liddle Formation at Souths Range (BLOODS RANGE). Ridge is approximately 500 m wide. (**c**) Festoon cross-stratified sandstone of the Liddle Formation in LAKE AMADEUS. This interval corresponds with the Liddle Formation "event" facies of Donnellan and Normington (2017) and informal Liddle C on **Figure 2**. Scale: 30 cm geopick. (**d**) Distinctive red, feldspathic sandstone of the Puna Kura Kura Formation in LAKE AMADEUS.

creating uncertainty in late Ediacaran lithostratigraphic correlations. Correlation of the lower Arumbera Sandstone, Puna Kura Kura Formation, and Carnegie Formation would suggest that the Liddle Formation is partly or entirely correlative with carbonate of the Julie Formation (**Figure 2**; Normington *et al* 2019). A caveat of this interpretation is that in much of the far western Amadeus Basin, the Carnegie Formation directly overlies the Bitter Springs Group with no intervening Julie Formation. A lower portion of the Carnegie Formation could, therefore, potentially correspond with older parts of the Winnall Group lying below the Puna Kura Kura Formation.

The regional-scale understanding of Ediacaran stratigraphy that has thus emerged from NTGS mapping of the Amadeus Basin is of an overall lateral transition from fine-grained siliciclastics of Pertatataka Formation and overlying carbonate of Julie Formation in the eastern Amadeus Basin, to fine-grained siliciclastics of Breaden and Gloaming formations and overlying sandstone of Froud and Liddle formations in the central basin, to sandstone of Liddle Formation in the westernmost Northern Territory portion of the basin, and finally, a return to carbonate of the Julie Formation in the far western Amadeus Basin in Western Australia (**Figure 2**; Haines and Allen 2014). Each of these successions is overlain by late Ediacaran sandstone of the potentially correlative lower Arumbera Sandstone (east), Puna Kura Kura Formation (central and west), and Carnegie Formation (far west). Liddle and overlying Puna Kura Kura formations may be stratigraphic counterparts of the late Ediacaran Bonney Sandstone (eg Counts *et al* 2016) and overlying Rawnsley Quartzite (eg Forbes 1971) in the Flinders Ranges of South Australia.

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