

CASE STUDY 1.001

The Wilpena Group (Flinders Ranges, South Australia); Stratigraphy, Correlation, and Geological History

Author: Steve Abbott*

Introduction

The Flinders Ranges (Figure 1) are made up of sedimentary rocks that were deposited during Neoproterozoic time in a sedimentary basin called the Adelaide Geosyncline. About 500 million years ago during Palaeozoic time the basin sediments were folded and faulted by mountain building processes. The mountains have eroded away but uplift during the last five million years has exposed the folded and faulted rocks as the rugged scenery we see today. The sedimentary rocks of the Adelaide Geosyncline include distinctive intervals of sandstone, mudstone, limestone and dolostone that can be mapped throughout the region. Such mappable intervals are termed formations and the arrangement of formations in the Earth's crust is referred to as stratigraphy. Stratigraphy is used to understand the geological history of an area and is applied to help find and manage earth resources.

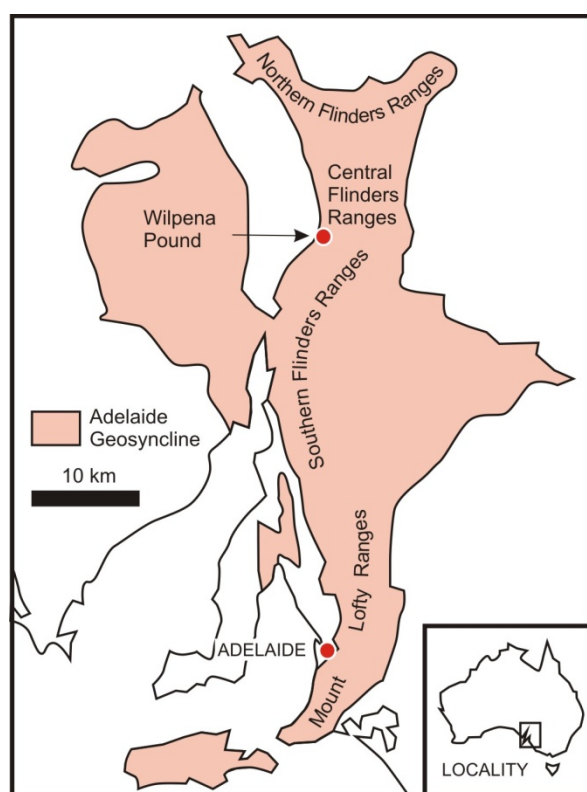


Figure 1. Locality of the Adelaide Geosyncline and the Flinders Ranges.

Main content

The spectacular skyline of Wilpena Pound, in the central Flinders Ranges (Figure 2), comprises an orange-hued sandstone that is hard and resists weathering and erosion. The same sandstone similarly forms the skyline of the nearby Heysen Range and Elder Range. This distinctive sandstone is a formation, that is, a mappable body of rock that is characterised by its rock type and other features such as mineral composition and colour. Formation names are typically based on a local geographic feature and its main rock type. The orange sandstone formation is called the Rawnsley Quartzite after Rawnsley Bluff and the rock type of which it is made¹.

Several other formations can be seen in Figure 2. Beneath the ridge-topping Rawnsley Quartzite is a reddish-hued sandstone called the Bonney Sandstone. Beneath the Bonney Sandstone is a greyish-hued interval of limestone and siltstone called the Wonoka Formation. The greenish siltstone in the foreground is called the Brachina Formation. These formations and many others are the basis of geological maps of the Flinders Ranges. Part of such a map, that includes the Wilpena Pound area, is shown in Figure 3.

¹ A more appropriate name would be Rawnsley Sandstone as quartzite is a metamorphic rock type.

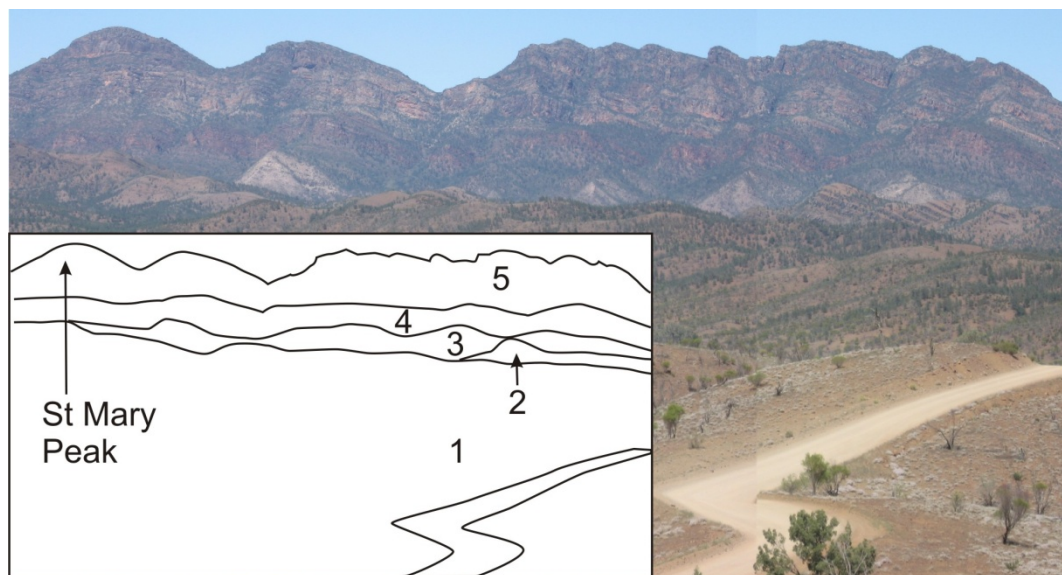


Figure 2. Panoramic photograph looking south towards the northern rim of Wilpena Pound (see Figure 3 for location). St Mary Peak is at far left. The inset shows the distribution of Wilpena Group formations. 1 = Brachina Formation, 2 = ABC Range Quartzite, 3 = Wonoka Formation, 4 = Bonney Sandstone, 5 = Rawnsley Quartzite.

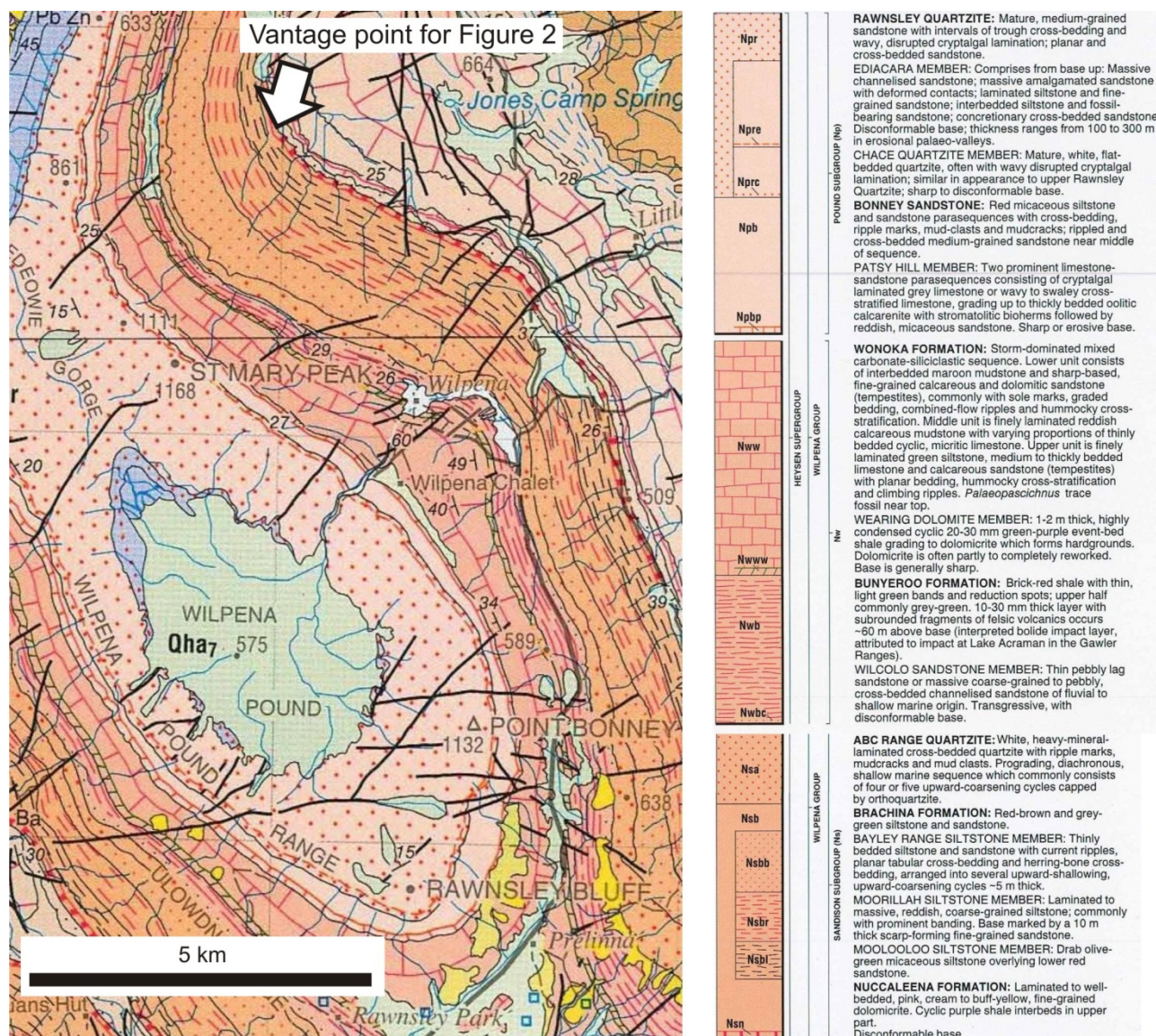


Figure 3. Excerpt of the Parachilna 1: 250,000 geological map. The basin-shaped landscape feature known as Wilpena Pound is a syncline rimmed by Wilpena Group formations. The Rawnsley Quartzite forms the skyline that includes landscape features such as Rawnsley Bluff and St Mary Peak. The location of the photographer's vantage point for Figure 2, looking SSW towards St Mary Peak, is indicated. Used with permission from Department for Manufacturing, Innovation, Trade, Resources and Energy (South Australia).

It is often useful to combine several formations into a thicker stratigraphic unit called a Group. The Rawnsley Quartzite, Bonney Sandstone, Wonoka Formation, Bunyerroo Formation, ABC Quartzite, Brachina Formation and Nucaleena Formation together comprise the Wilpena Group. The Wilpena Group has an estimated maximum thickness of 6,000 m and is one of 6 groups that make up the sedimentary fill of the Adelaide Geosyncline. In other situations, it is useful to sub-divide formations into smaller intervals called members. For example, the Rawnsley Quartzite includes an interval of sandstone and siltstone called the Ediacara Member.

The formations in the Wilpena Pound area can readily be followed and mapped into the nearby Heysen, ABC, Chace, Heysen and Elder Ranges. A similar succession of formations is recognized at other locations throughout the Flinders Ranges. However, there are often gaps of many kilometres between the areas of rocky outcrop so, at some locations, the formations have to be established by stratigraphic correlation. That is, the formations are matched from one area to another on the basis of their distinguishing features.

The stratigraphy of the Wilpena Group with its component formations and members in the Flinders Ranges is shown in Figure 4. The table has been constructed by correlating formations between the southwestern, central, and northeastern Flinders Ranges, a distance of over 300 km. Most of the formations in Figure 4 extend throughout the Flinders Ranges which indicates that their respective environments of deposition were widespread. On the other hand, some formations grade horizontally into another. For example, the Rawnsley Quartzite grades horizontally into the Billy Springs Formation in the Northern Flinders Ranges. Such changes can occur when sandy sediments deposited in shallow water (Rawnsley Quartzite) grade into silty sediments (Billy Springs Formation) deposited in deeper water.

SOUTHERN FLINDERS RANGES	CENTRAL FLINDERS RANGES	NORTHERN FLINDERS RANGES
WILPENA GROUP		
	Rawnsley Quartzite	Billy Springs Formation
	Bonney Sandstone	
	Wonoka Formation	
	Bunyerroo Formation	
ABC Range Quartzite	Brachina Formation	Ulupa Siltstone
	Nucaleena Formation	

Figure 4. Simplified Wilpena Group Stratigraphy. Members have been omitted for clarity but are included in the legend of Figure 3.

Stratigraphy is the basis for interpreting the geological history the Earth's crust. Such a history is devised in the context of relative geological time which refers to the ordering of rock formations or geological events from oldest to youngest. Thus the first step in the geological history of the Wilpena Group was that its formations were laid down horizontally in the Adelaide Geosyncline sedimentary basin (according to the Principle of Original Horizontality). Furthermore, the Nucaleena Formation is the oldest formation and each overlying formation is younger than the one beneath it (according to the Principle of Superposition). If there is a lateral transition between one formation and another, such as the Rawnsley Quartzite and the upper part of the Billy Springs Formation, then the units are of the same age.

The Australian Stratigraphic Names Database, hosted by Geoscience Australia, contains over 28,000 formal stratigraphic names. The stratigraphic units (e.g. groups, formations and members) in the database are defined following formal guidelines so that they can be used as a common language by geoscientists to communicate geological knowledge. One of the main uses of stratigraphic information is exploration for Earth resources such as metals, petroleum, coal and water. Stratigraphic information is also useful to soil scientists, geographers and engineers, for activities as diverse as soil mapping, land-use planning and geological hazard mapping.

References

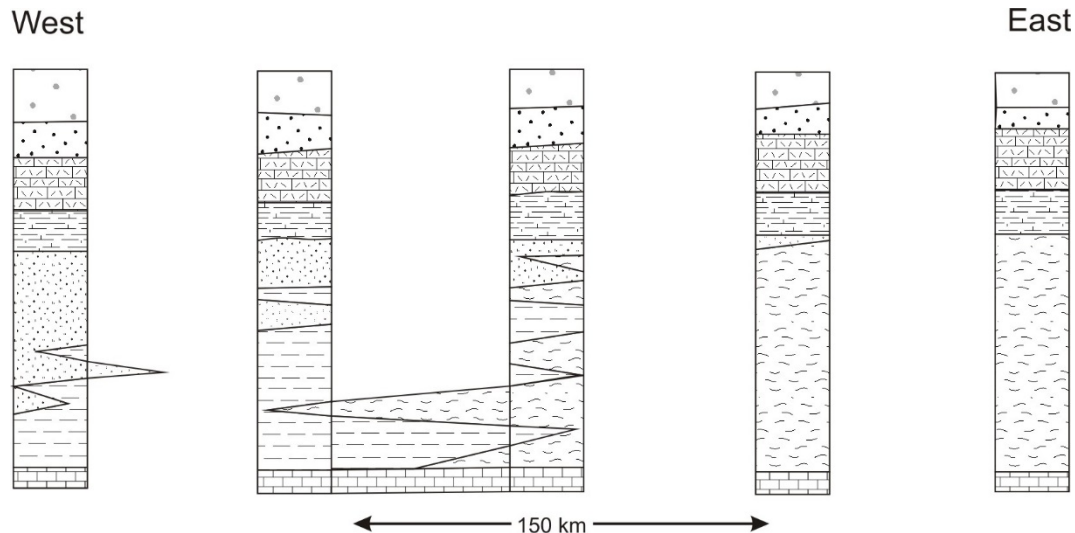
- Geoscience Australia. 2012. Products – Maps. <http://www.ga.gov.au/cedda/maps/1084> viewed May 6 2013.
- International Commission on Stratigraphy. 2013. Stratigraphic Guide. <http://www.stratigraphy.org/index.php/ics-stratigraphicguide> viewed May 6 2013.
- Lenz, SL, Brown, CE, Bond, LD and Ryburn, RJ. 1996. Guide to the Australian Stratigraphic Names Database. *Australian Geological Survey Organisation Record*, 1996/16.
- Priess, WV. 1987. Chapter 10 Tectonics of the Adelaide Geosyncline. In: Priess, WV (Compiler) Adelaide Geosyncline—Late Proterozoic Stratigraphy, sedimentation, palaeontology and tectonics. *Geological Survey South Australia Bulletin*, 53.
- Priess, WV, Belperio, AP, Cowley, WM and Rankin, LR. 1993. Chapter 6 Neoproterozoic. In: Drexel, JF, Priess, WV and Parker, AJ. The Geology of South Australia Volume 1, The Precambrian. *South Australia Geological Survey Bulletin*, 54.
- Reid, P and Priess, WV. 1999. PARACHILNA Map Sheet. South Australia. *Geological Survey. Geological Atlas 1:250 000 Series*, Sheet SH54-13.

*Steve Abbott is a geologist with considerable experience in academic research, undergraduate teaching, geological mapping and industry exploration with particular experience in basin analysis and sedimentology.









The Wilpena Group (Flinders Ranges, South Australia); Stratigraphy, Correlation, and Geological History

Author: Steve Abbott

Student Activity:



Legend

	Medium-grained sandstone. Sedimentary structures include trough cross-bedding and crypt-algal lamination.
	Red micaceous siltstone. Sedimentary structures include ripple cross-lamination, cross-bedding, and mud cracks.
	Mixed sequence of siltstone and sandstone; often dolomitic or calcareous. Characterised by hummocky cross-stratification.
	Brick-red shale. Includes a meteorite impact layer at some locations.
	White sandstone with ripple marks and cross-bedding. Heavy mineral laminations.
	Red-brown and grey-green siltstone and sandstone.
	Red-brown weathering siltstone.
	Laminated pink dolomiticite.

Formation name

.....

.....

.....

.....

.....

.....

.....

.....

Figure 5. Stratigraphy of the Wilpena Group in the Southern Flinders Ranges.

- Figure 5 shows a number of stratigraphic columns from locations across the southern Flinders Ranges. Each column is divided into formations using different patterns and a description for each formation is given in the legend. Complete the following using the figures and text in this case-study for clues;
 - Correlate the formations to show the stratigraphy of the Wilpena Group in the southern Flinders Ranges. Some of the correlations have been completed as a guide. It may be helpful to colour each formation in a different colour.
 - With reference to Figures 3 and 4, identify the formations in Figure 5 and write their names in the spaces provided.
 - Is the ABC Range Quartzite in the west older, more or less the same age or younger than the Ulupa Siltstone in the east? Why?
 - Based on the arrangement of formations, which end (i.e. west or east) of your lithostratigraphy in Figure 5 is closest to the edge of the Adelaide Geosyncline sedimentary basin? Try to justify your answer.
- Look at the legend of Figure 3 and locate the Ediacara Member.
 - To which Formation does the Ediacara Member belong?

- b) What does the Ediacara Member possess that is absent in all other Wilpena Group units?
 - c) Do a Google search of the Ediacara Member and write down some dot-points as to why it is of international geological significance.
- 3) Go online to <http://www.ga.gov.au/cedda/maps/1084> and follow the links to the scanned 1:250,000 Geology Maps for Australia.
- a) Download and view the geological map for your area.
 - b) Examine the map and find out the names, rock types, and ages of the geological formations present at your school, where you live, and some prominent local landmarks.
 - c) If your map shows mines or quarries, see if you can find information in the map legend about the resources that were exploited and the names of the formations that host them.

www.tesep.org.au