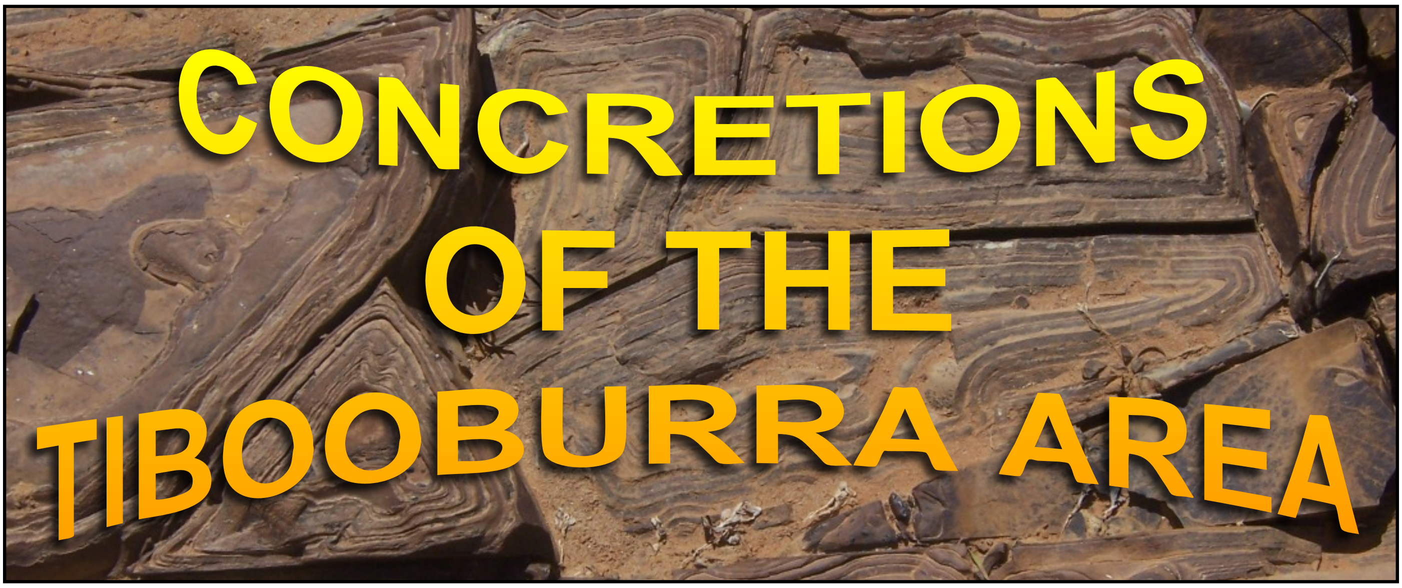


Concretions are accumulation of one or more minerals within the body of a sedimentary rock, or within cracks and cavities in a rock. They form when minerals such as quartz, iron oxides or calcium carbonate either precipitate as successive layers around a nucleus such as a mineral fragment, shell or pebble, or occupy the pore spaces in a particular layer of sandstone, shale or other sedimentary rock.

The Tibooburra-Milparinka region in northwest New South Wales contains an abundance of varied concretions. Some are formed from dark brown to orange iron oxide, whereas others are composed of calcium carbonate or hard, pale grey silica. Their styles include concentric spheres and blocks, massive spheres up to metres across, curved plate-like slabs, flat slabs, cross-hatched slabs and very irregular masses. Many are very photogenic. They occur from the base of the Cretaceous sedimentary rocks to the Tertiary silcrete (see Tibooburra Dome tour and Tibooburra Inlier tour on this web site).

This is a pictorial guide to the many different forms of concretion occurring in this region. A few specific localities are given for some concretions. However, it is recommended that the specific geological settings for each concretion type should be investigated using the regional geological maps downloadable from our web page, or the more detailed 1:100 000 scale maps available from the Geological Survey of New South Wales. The geological settings are described in conjunction with each concretion type.

IRON OXIDE CONCRETIONS

The majority of interesting iron oxide (*ironstone*) concretions occur close to the base of the Cretaceous rock series, near their contact with the Cambrian metasedimentary rocks or Silurian granodiorite. Searching around the margins of the ancient inlier rocks near Tibooburra or Milparinka will reveal small to large areas of ground littered with dark brown iron oxide fragments which are largely fragmented concretions and fracture fillings. Many of these are composed mainly of massive ironstone with little structure. However, with persistence, sites will be found with well structured concretions, both along the ground surface and in creeks.

Abundant iron oxides will also be found topographically below the contact of the Tertiary rocks with Cretaceous strata. From experience, the extensive ironstone cover associated with this setting is usually non-structured, although exceptions occur.

The iron oxide which comprises these concretions has been derived mainly from the chemical weathering of iron-rich minerals in local rocks. In particular, pyrite is abundant in some of the Cretaceous rocks, and this weathers rapidly on exposure to groundwater to form iron oxides.

We have recognised a number of informal, descriptive categories of ironstone concretions from this area:

1. Concentric
2. Hollow, including “rattle rocks” and pipes
3. Layered slab
4. Cross-hatch slab
5. Trace fossil slab, and
6. “Melted chocolate”

Photo 1. Multi-sided concentric ironstone concretions. From a creek bed southeast of Whitta-Brinnah homestead.

Concentric Ironstone Concretions

These occur in a range of forms, including spherical, flattened spheres, and 3 to 6 sided bodies. Some occur singly, whereas others, particularly the multi-sided concretions, occur as aggregates in a single flat bed.

The most interesting of these are the multi-sided concretions (Photos 1 - 7). These have formed as a single bed of concentric concretions which have come into contact with their neighbour whilst still growing. The growing concretions have squeezed and squashed their neighbours, resulting in a wide range of sizes and shapes.

Individual concretions break away from the bed forming multi-sided columns up to 15 cm long .

Photo 2. Multi-sided concentric concretion with a relatively soft core.

Photo 3. Multi-sided concentric concretions showing effects of differential erosion of softer vs harder layers.

Photo 4. Multi-sided concentric ironstone concretion.

Photo 5. Multi-sided concentric ironstone concretion.

Photo 6. Multi-sided concentric concretion with relatively soft core.

Photo 7. Multi-sided concentric concretion with “melted chocolate” effect.

Photo 8. Concentric ironstone concretion with differential erosion of layers.

Photo 9. Spherical, concentrically layered ironstone concretion. Exfoliating outer layers form plate-like fragments as in Photos 10 and 11.

Photo 10. Plate-like concentric concretion.

Photo 11. Plate-like concentric ironstone concretion. This is the exfoliated outer section of a larger flattened sphere-like concretion.

Hollow Ironstone Concretions

These occur in a two main forms:

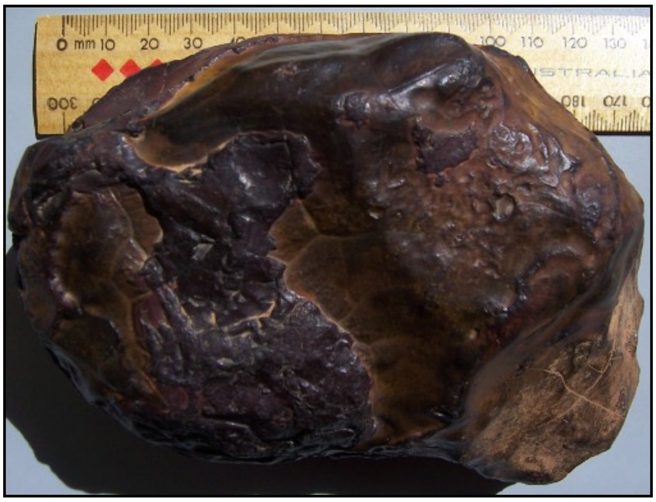
1. Open pipe-like
2. Closed spherical

Hollow ironstone concretions are variants of the previously described concentric concretions in which the core is very soft and has eroded or been dissolved away, leaving a void. Some enclosed concretions retain a loose fragment of rock or mineral which moves about when the concretion is shaken, emitting an audible sound. These are locally referred to as *rattle rocks*.

Photos 12 & 13. An ironstone pipe concretion. Note the concentric layering in the walls.

Photos 14 & 15. Ironstone pipes with flat external faces. The pipe is open at both ends of the concretion.

Photo 16. A gourd-shaped ironstone concretion, with one opening.



Photos 17 and 18. Rattle rock concretions, showing typically smooth, exfoliated outer surfaces. Both examples are about the same size.

Photo 19. Rattle rock concretion approximately 20 cm long. Note the smooth, pebble-like outer surface and thin exfoliation layer.

Layered Slab Ironstone Concretions

These are horizontally layered concretions which have undergone differential erosion, resulting in alternating prominent and recessed layers. Some show preserved woody fossil traces, suggesting that the original rock was a fossiliferous shale which has been indurated with iron oxides.

Photos 20 & 21. Examples of horizontally layered slab concretions

Cross-hatch Ironstone Concretions

These are unique and interesting concretions, comprising overlapping and intersecting ironstone layers with voids in between layers. Some show fossil wood textures, suggesting that the concretions have formed within fossiliferous shales.

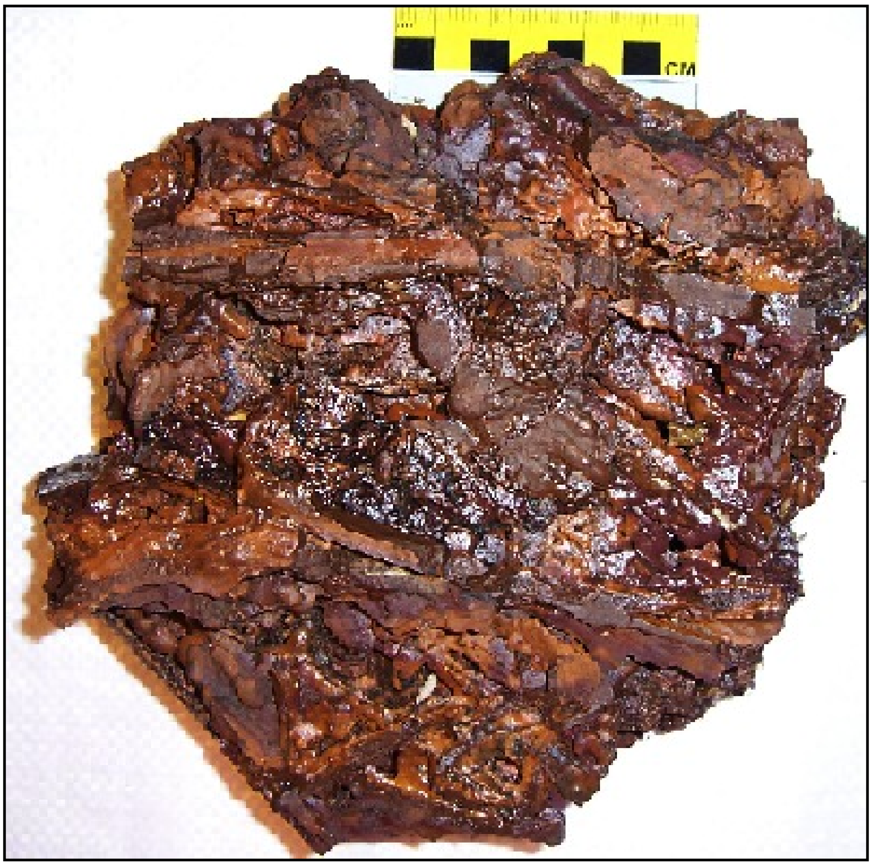


Photo 22. Top surface of a horizontally layered slab concretion.

Photo 23. Cross-hatch ironstone concretion approximately 10 cm wide. These may be replacing silt-infilled mudcracks.

Photo 24. Cross-hatch concretion with several possible fragments of ironstone-replaced fossil wood.

Photo 25. Cross-hatch concretion.

Photos 26 & 27. Further variations of cross-hatch concretions.

Trace Fossil and Mudcrack Concretions

These are unique and interesting concretions, with what appear to be preserved traces of the trails and burrows of marine or aquatic organisms. These are known as *trace fossils*. The traces are commonly curved and meandering and commonly intersecting. These were probably grazing paths or organisms feeding on the surface sediment layer. Some are vertical and infilled tube-like, and possibly represent shallow burrows produced by organisms for shelter from predators or strong currents. Some also are composed of straight to curved, rectilinear features; these may be infilled mud cracks. The photos below display the range and unique textures of these concretions, which probably formed from the selective iron oxide induration of a fine sand or silt layer.

Photos 28-34. Examples of trace fossil concretions. All were collected from near the base of the Cretaceous rocks on Mt. Stuart station.

Photo 35. A sample of trace fossil concretion. Note the discontinuous diagonal lines on the rock. These probably resulted from a current scouring the sediment layer. Such features are known as "streaming lineations".

Photo 36. A trace fossil concretion with preserved vertical burrows.

"Melted Chocolate" Concretions

These are unusual concretions with glossy, dark brown, curved surfaces of iron oxide. This texture is known as *botryoidal*. It gives the concretion the distinctive appearance of melted globules of chocolate.

The photos below display the many and varied forms of these concretions. This form is common near the base of the Cretaceous strata.

Photos 37 & 38. "Melted chocolate" concretions, composed of botryoidal iron oxide.

Photos 39-44. Examples of "melted chocolate" concretions.

CALCIUM CARBONATE CONCRETIONS

Many concretions within the Cretaceous rocks of the region are composed of calcium carbonate (*lime*). These concretions are generally simple in form, generally with a spherical shape. They occur singly or in groups, and may intergrow with one another. Their size is very variable, ranging from about 20 cm diameter to several metres across. Their colour ranges from grey to dark grey-green. An internal concentric layering is generally poorly developed. Examples and some localities of these concretions are described in the Tibooburra tour guides downloadable from this site.

Photos 45 & 46. Spherical (partially buried) and unusual, filled horizontal pipe-like concretions which have been eroded from underlying Cretaceous sandstones.

SILICA CONCRETIONS

The prominent mesa-like cordillos in the Tibooburra-Milparinka region are commonly capped with silcrete. This hard, erosion-resistant rock was once a sandstone, but has been indurated with silica (quartz) during a significant weathering event about 33 million years ago. Groundwater movement dissolved silica from some rocks and redeposited it within the sandstone which was slowly converted to *groundwater silcrete*. Over time some rocks had silica removed, redeposited, and removed again, in some cases producing unusual surface textures of concretionary origin. The textures include solution cavities and embayments, surfaces with a sculpted appearance, and glassy, high gloss surfaces. These groundwater silcretes are to be found low in the profile of the thick silcrete sheets capping the cordillos. Often they are represented by conglomerates composed of pebbles of glossy silcrete. Occasionally, exotic forms such as those shown below may be found.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