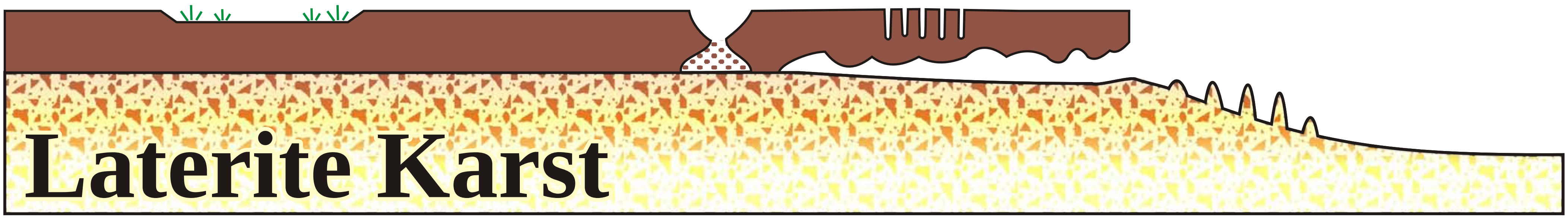


Laterite Karst

Terminology, Processes & Profiles

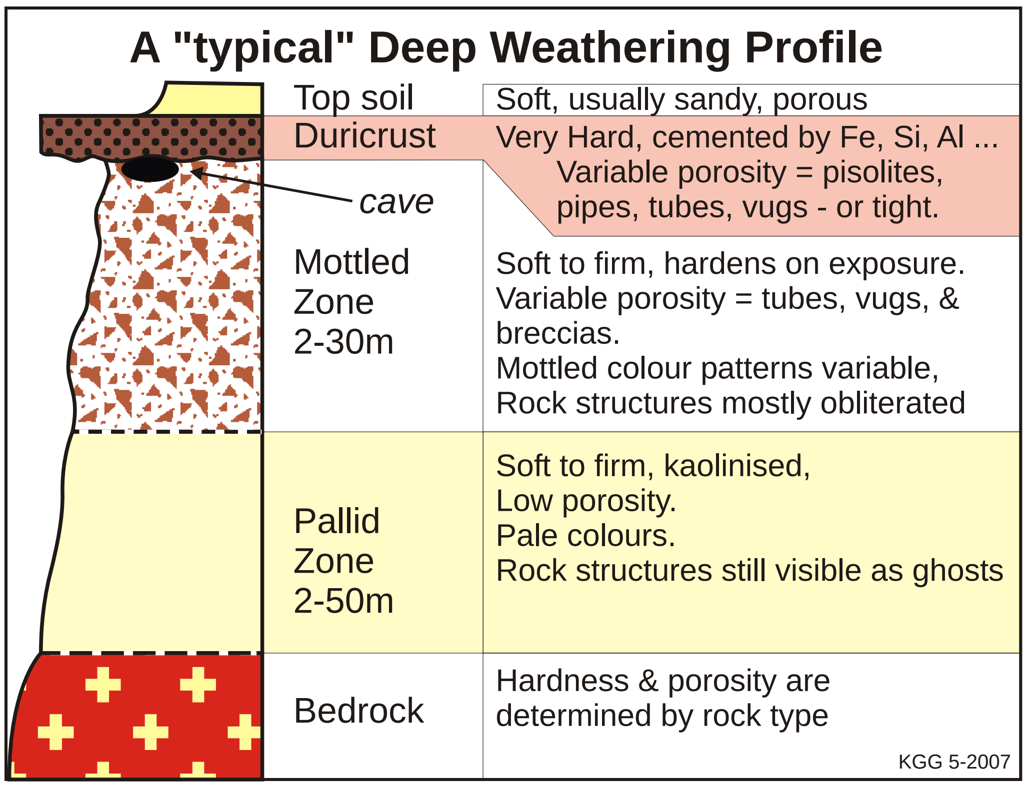
Laterites & Deep Weathering

Deep Weathering: is the intensive chemical weathering of a rock over a long time.

A Deep Weathering Profile (DWP) typically comprises a duricrust (ferricrete, silcrete, etc) over a mottled and pallid zone (see figure).

Laterite is a type of DWP, rich in iron

Canga is an iron rich laterite in S. America



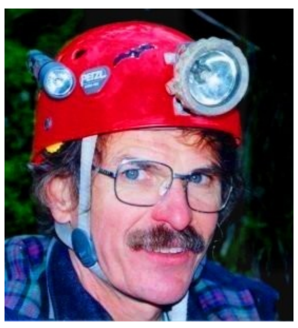
Deep weathering

Deep weathering involves the intensive chemical weathering of the minerals in a rock over a long period of time. The minerals are converted to new forms which may be soluble, and can be removed in solution (analogous to karst); or may be softer, such as clay minerals, or crumbly, such as residual sand grains, and can be removed by flowing water, e.g. by piping, or by other mechanical processes. Both solution and mechanical erosion produce cavities and other karst-like forms.

Localised precipitation of the dissolved material forms hard bands, duricrusts, which provide a solid roof below which caves can form. Focused cementation can also form pinnacles.

Author: *Ken G. Grimes,*

Consultant Geologist,
Regolith Mapping,
RRN 795, Morgiana Rd.,
Hamilton, Vic 3300, Australia.
ken.grimes@bigpond.com



Karst, Parakarst & Pseudokarst

Karst Landforms are a set of special features associated with limestones.

The Karst Process is dominated by solution

The main Karst Rocks are the carbonates

Karst is karst landforms on karst rocks

Parakarst is karst landforms on other soluble rocks. Solution is critical but may not be the dominant process.

Pseudokarst is karst landforms formed by processes other than solution.

Laterite Karst has karst landforms formed by both solution and other processes – it overlaps with parakarst and pseudokarst.

Laterite Karst

➤ Laterites and other DWPs can exhibit a broad range of karst-like landforms, at all scales from broad hollows (pans), through caves, pinnacles and pipes to small vugs, tubelets and breccias.

➤ Laterite Karsts show a particularly strong analogy to the Syngenetic Karsts. In both, the karst landforms evolved at the same time as the "rock" was being cemented.

➤ Karst-like features in quartzites may be a special case where the lack of labile minerals restricts chemical weathering to solution only.

Ferricrete overlying an "epikarst" surface with cutters and pinnacles on a mottled claystone. Excavation at Darwin, NT.

Laterite Karst

Large-scale karst landforms

Pans: broad, shallow, flat-floored or basin-shaped hollows on lateritic plains.

Collapse Dolines: deep sinkholes in laterite.

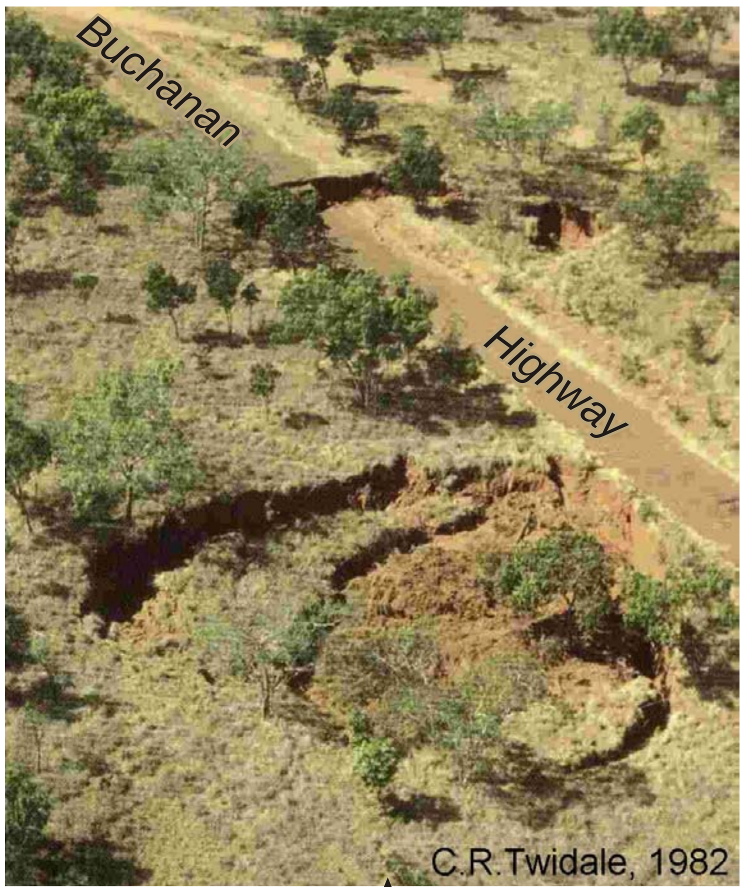
Ruiniform relief: joint-controlled dissection.

Pans: On broad areas of undissected lateritic plain or plateau we find fields or isolated occurrences of broad but shallow closed depressions (**pans**) and related flat-floored low-order valleys (**dambos**). The shallow pans are essentially solution/subsidence dolines, but depth-limited by the shallow nature of the solutional zone, which is in and immediately beneath the duricrust. Borger, et al (2004) and McFarlane et al (1995) describe examples from near Darwin, NT. Once formed, deflation of seasonally-dry pan surfaces may help to deepen and extend them, and care is needed to avoid confusing the processes. The best Australian examples are on the west coast of Cape York Peninsula and the Doomadgee Plain, Qld.

Collapse dolines have been reported from the lateritic Sturt Plateau of the Northern Territory (McFarlane & Twidale, 1987), but the laterite is underlain at a depth of 50-100m by a limestone formation so it may be that these are subjacent karst features rather than due to silicate solution. The best examples occur near the Buchanan Highway, which had to be re-routed to avoid them!

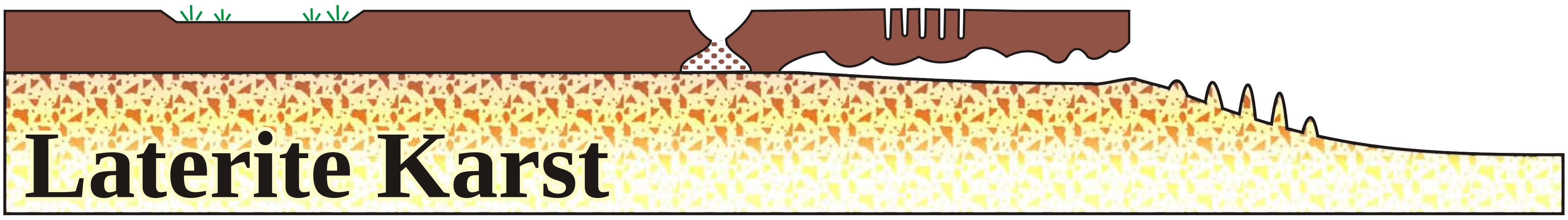
Ruiniform relief: Some **duricrusts** have strong jointing which forms grikes or cutters, and these can break up into "stone cities" analogous to those found in quartz sandstone parakarst.

Pans and *dambos* on a lateritic plain, west coast, Cape York Peninsula, Qld.



Collapse dolines
Sturt Plateau, NT

Grikes & "stone city" *blocks in duricrust, Donors Plateau, Qld.*



Laterite Karst

Caves

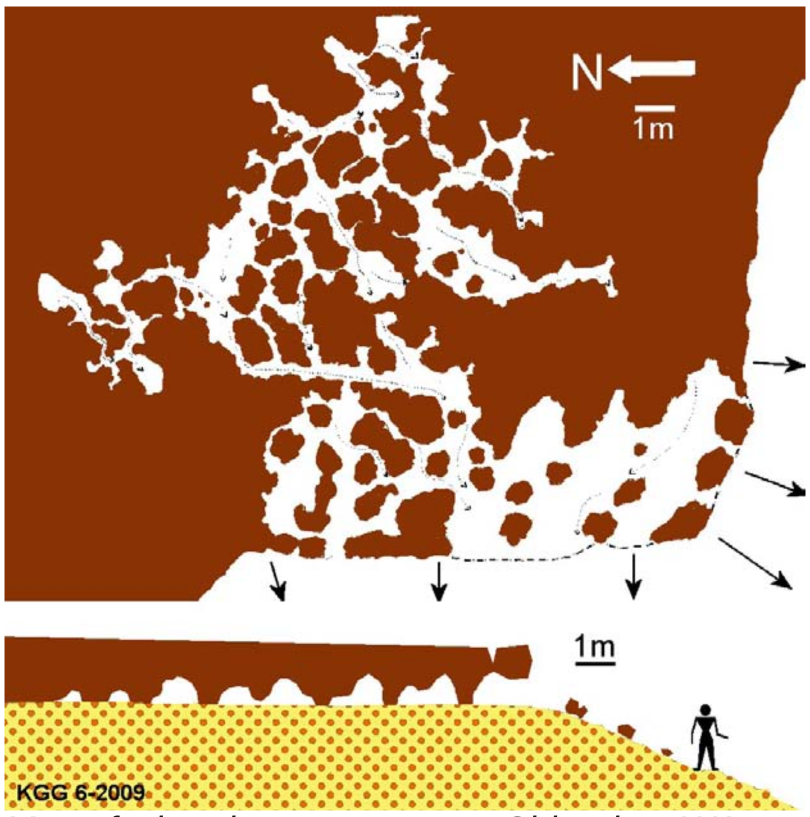
> ***Rock Shelters*** *are common,*
> ***True caves*** *are less common, but include some mazes and linear stream caves.*

Rock shelter with hanging visor, in a laterite cliff, Biloela, Qld.

Caves are most common in the soft mottled zone beneath a hard duricrust (ferricrete, canga, etc). They form mainly by cavernous weathering (tafoni) or by piping.

Rock shelters: These are the most common type and are overhangs that do not extend far into the cliff. They may have archaeological interest.

True Caves: These extend further in than their width, and may have a dark zone. Most are small and close to a cliff but may have multiple low chambers connected by passages. There is a small maze system at the edge of a laterite plateau in Western Australia (Lefroy & Lake, 1972 - map below) and linear caves with streams have been reported beneath laterite crusts in Africa (e.g. Vicat, & others, 1995). Laterite caves are commonly low-roofed with pendants and pillars of better-cemented material.



Map of a laterite maze cave at Chittering, WA., After Lefroy & Lake (1972), with profile by KGG.

Cave under laterite crust at Chittering. Above: roof pendants and a small solution pipe with cemented rim (arrowed). Below: laterite pillars divide the cave into a maze of small passages. 10 cm scale bar.

Laterite Karst

Medium-scale features

Dolines: both solutional and subsidence types.

Pinnacles: focussed cementation

Solution pipes: focussed solution & excavation of soft residue

Grikes and **clints** on ferricrete surfaces.

Polygonal walls: between wide areas of softer material.

Small ***solution dolines*** can occur within a laterite surface, generally beneath a sandy soil (photo below). Adjacent to a scarp, piping of soft material from beneath a duricrust may cause **subsidence** hollows.

Solution pipes and (less commonly) ***pinnacles*** are a result of focussed vertical solution and cementation respectively. The two may work together to produce hollow pinnacles; that is, a pipe with a cemented rim. Cemented pinnacles form within the laterite and are exposed by erosion of the softer surrounding material. Dense fields of pipes may coalesce and leave residual pinnacles between them.

Some pipes have breccia, soil or nodule ***fill***. This may later be removed to leave an empty pipe.

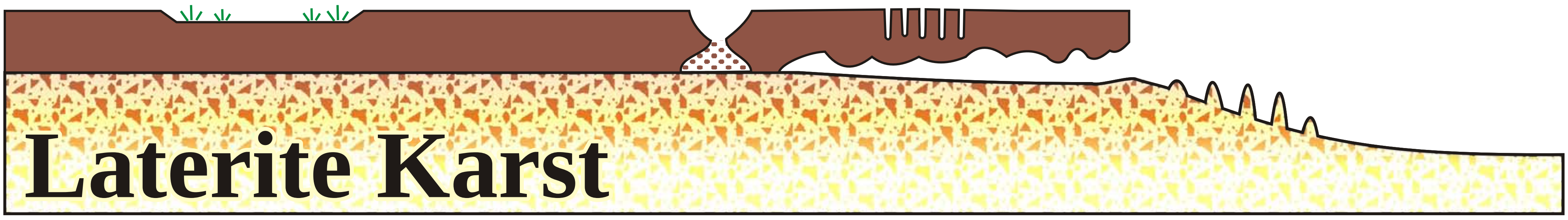
Grikes & Clints: Ferricrete surfaces frequently break up into rectangular or polygonal blocks, which become rounded.

Peculiar to laterite karsts are areas of low "***polygonal walls***" which seem to be better indurated areas between either wide, almost coalescing tubes with a soft fill, or giant mottles of soft leached material.

*Solution(?) **dolines** and **pipes** in a mottled zone. An original soft soil fill has been removed. "The Mystery Craters", SE Qld.*

Pinnacles, White Mountains NP, Qld

⬆ ***Solution pipes:*** *breccia-filled & open.*
⬇ ***Polygonal Walls****, Lake Buchanan, Qld.*



Laterite Karst

Small-scale features

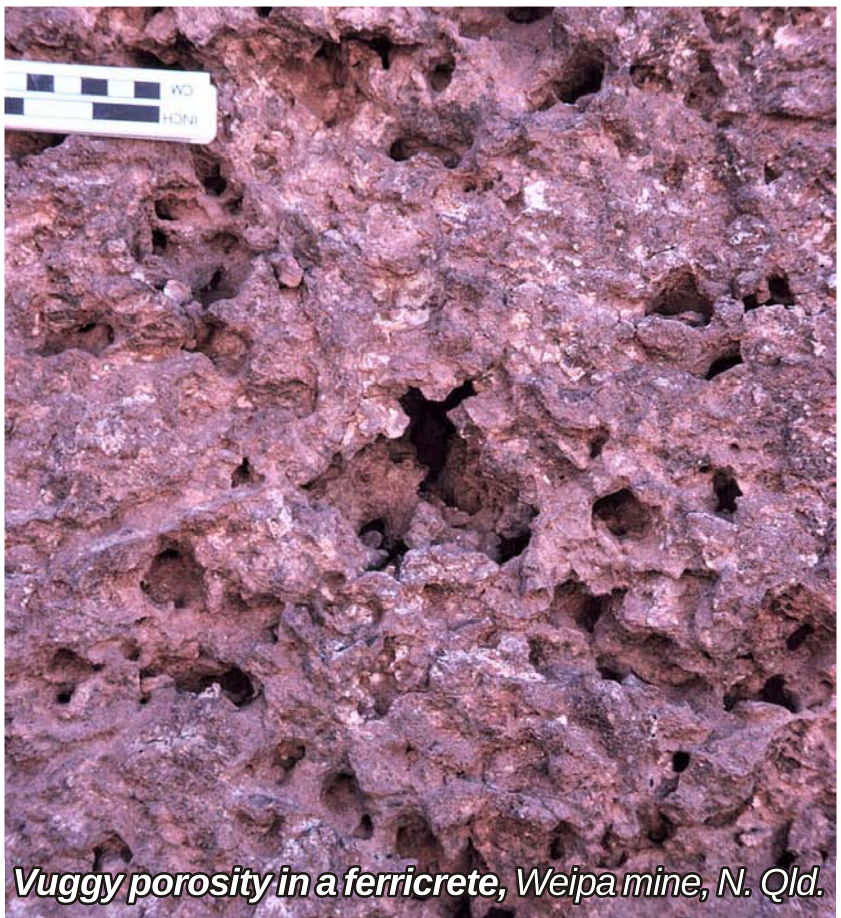
Vugs: isolated or interconnected.
Tubelets: small, 1-2cm wide, in networks
Breccias: form pockets, bands etc.
Speleothems: in caves and smaller vughs.

Vugs: Small irregular solutional cavities are common in ferricretes and other duricrusts. They can be equi-dimensional, flattened, or grade to tubelets.

Tubelets: nets of small solution tubes, 1-2cm wide penetrate both the duricrust and the underlying mottled zone. Some authors suggest excavation by termites, who certainly use them but may not have dug them.

Breccias: Solution-induced breakdown can form crackle breccias of minimal displacement, or further displaced fragments, which can be rounded and coated by secondary minerals.

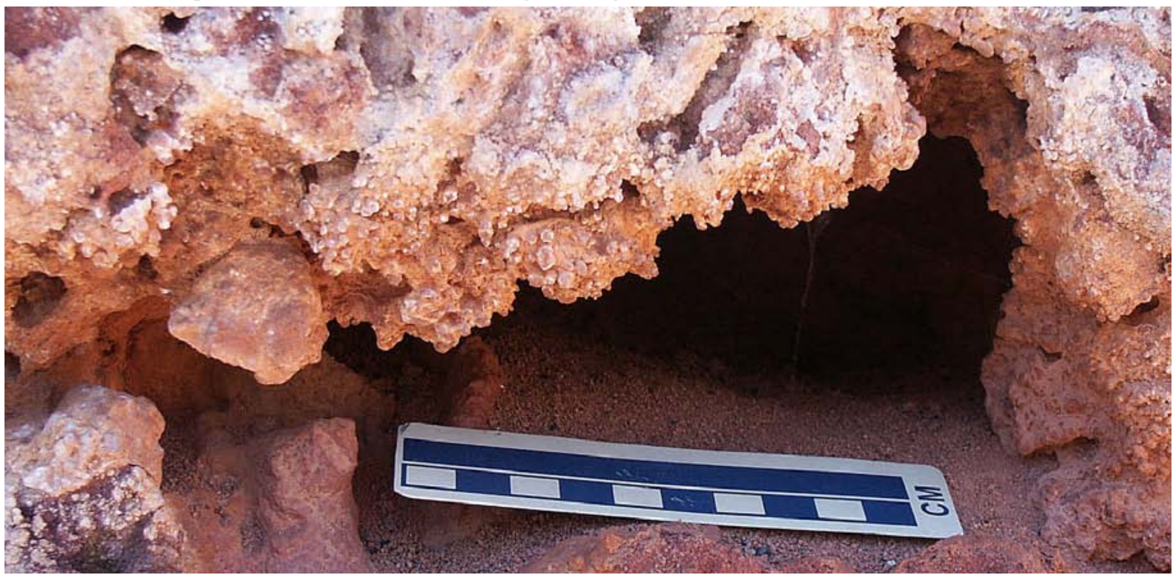
Speleothems: various oxides and opal form small coralloid and flowstone deposits in hollows.

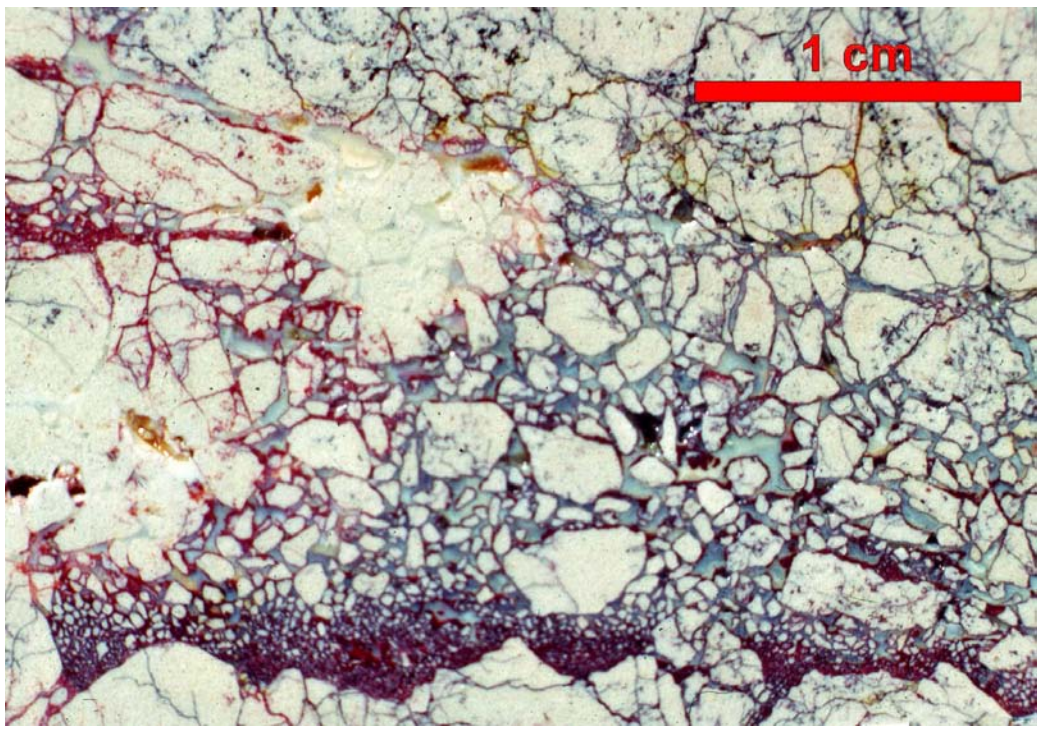


Vuggy porosity in a ferricrete, *Weipa mine, N. Qld.*

Solution Tubelets with leached halos

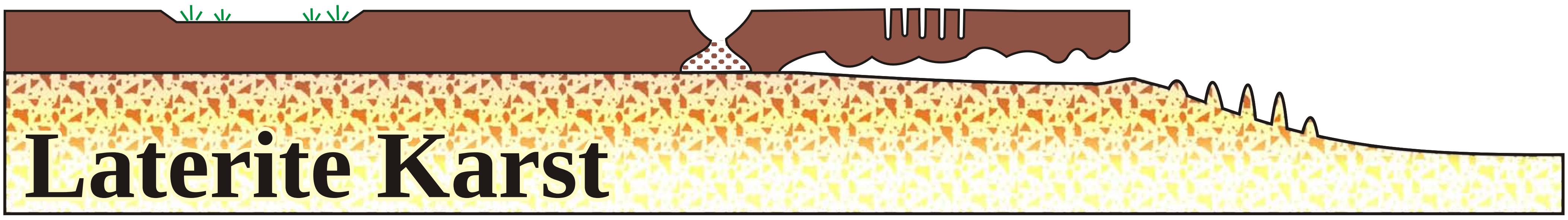
Coralloid speleothems *in a large vug*





Breccias: Left: *A pocket of breccia within a coarsely mottled siltstone bed.* ***Right:*** *This is a miniature analog of a cave breakdown chamber. The roof is stoping upward and the fragments are disintegrating and being replaced by a dark insoluble residue. Grey matrix is a later opal fill.*

Laterite Karst



Comparisons with Syngenetic Karst

Syngenetic karst forms on calcarenite dunes by simultaneous cementation and solution. Lithification and karstification are simultaneous.

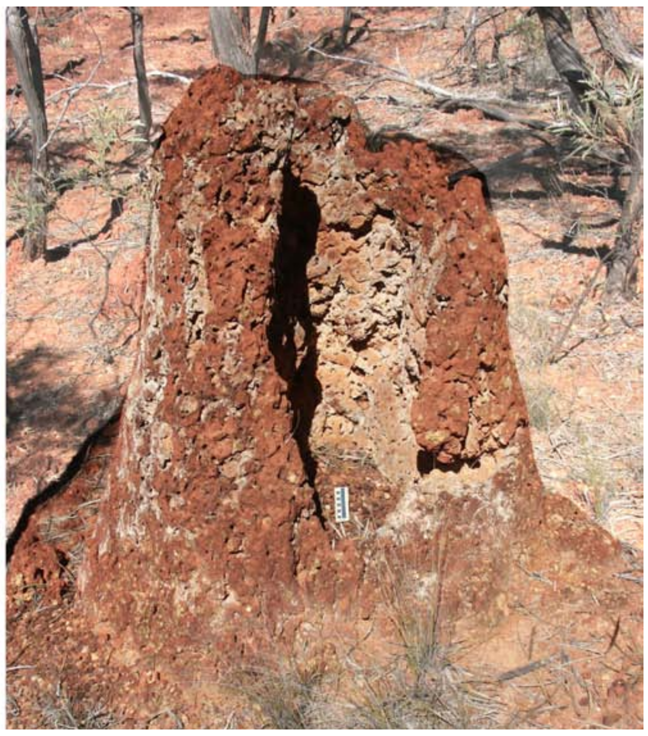
Laterite karst shows a stronger analogy with the syngenetic karsts in soft porous calcarenites (Grimes, 2006) than with the classic 'hardrock' karsts.

Both laterites and syngenetic karsts have simultaneous solution and cementation and show the influence of caprocks (duricrusts) on cave development.

Both types show fields of solution pipes, and locally of cemented pinnacles.

Caves form under caprocks in both cases, and cemented roof pendants and pillars are features in both types of cave. But most laterite caves have been excavated by piping rather than by solution of the rock.


Comparisons of Syngenetic karst (left) and Laterite karst (right)
Fields of solution pipes (above) and hollow pinnacles (below)

***Caprocks** with caves & shelters forming beneath them.*
Below: Syngenetic calcrete caprock with cemented pendants. Naracoorte, SA.
Bottom: a laterite duricrust with pendants and pillars. Chittering cave, WA.

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