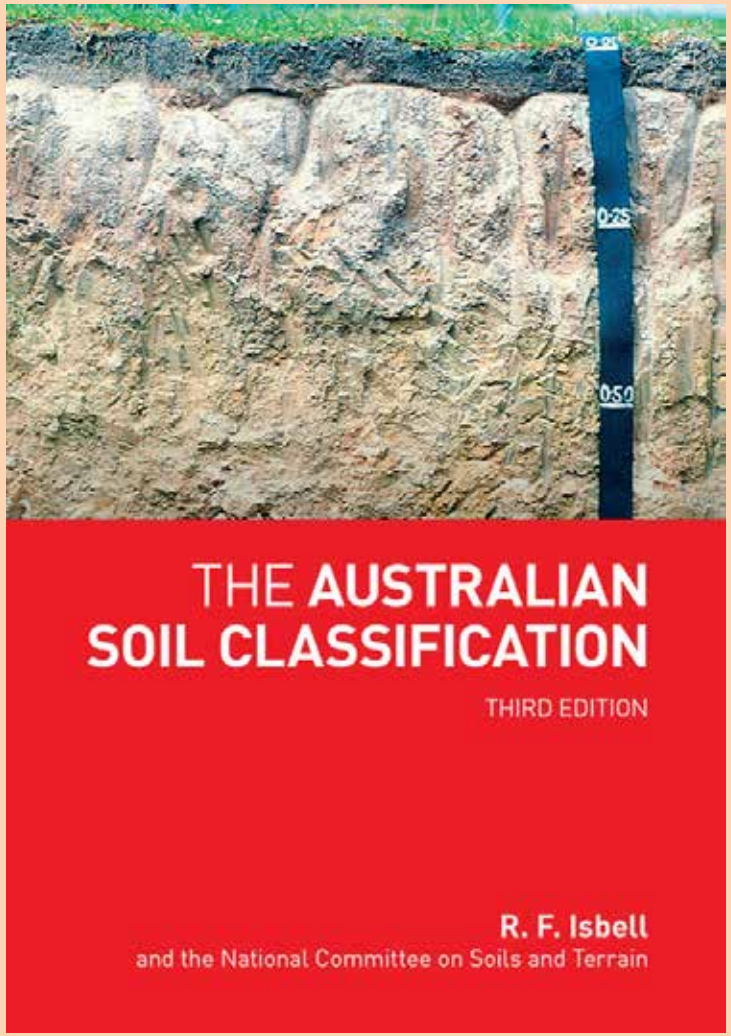


Sands ain’t Sands– how Australia’s Soils Classification deals with sandy soil diversity

Bernie Powell & Noel Schoknecht

The challenges with classifying sandy soils

- **Definitions of sand and sandy soil - many options**
  - **Sand** - particle size standards,
  - **Sandy soils** - soils with sandy texture, but how deep and how sandy? Generally >80% sand.
- **Extent** - Do we mean sandy **Profiles** or **Horizons** or both?
- **Where is the cutoff?**
- **Aim**- consistency of meaning and the most useful vocabulary

What do most sand particles have in common?

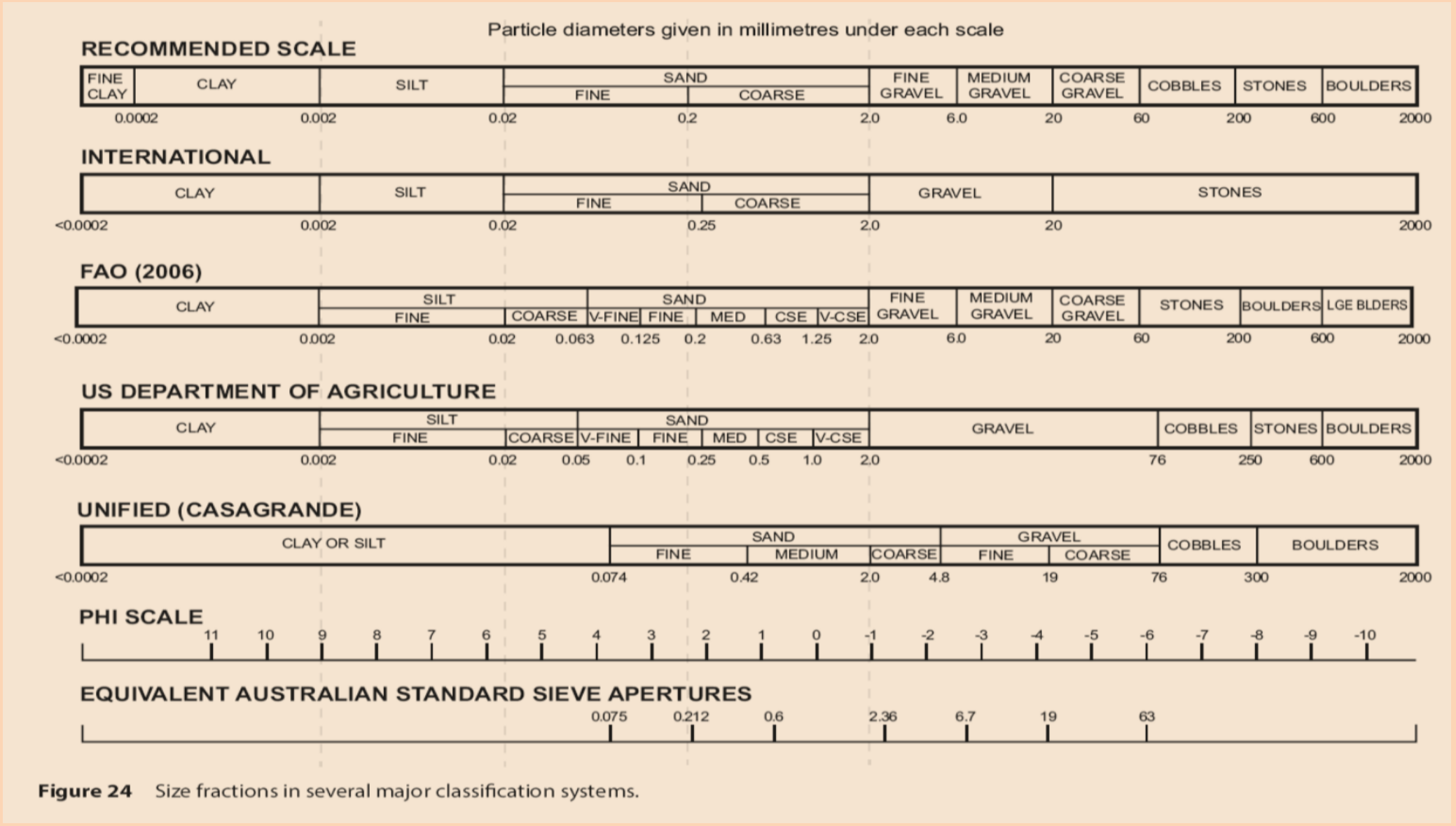


Figure 24 Size fractions in several major classification systems.

Sandy soil **field** textures (> 80% sand)

- Sand <5% clay - nil coherence
- Loamy sand, clayey sand - 5-10% clay (slightly coherent)
- Sandy loam - 10 – 20% clay (coherent)
- Sandy clay loam - 20-30% clay strongly coherent

The size of the dominant sand particles may modify the field texture into fine, medium or coarse sandy.

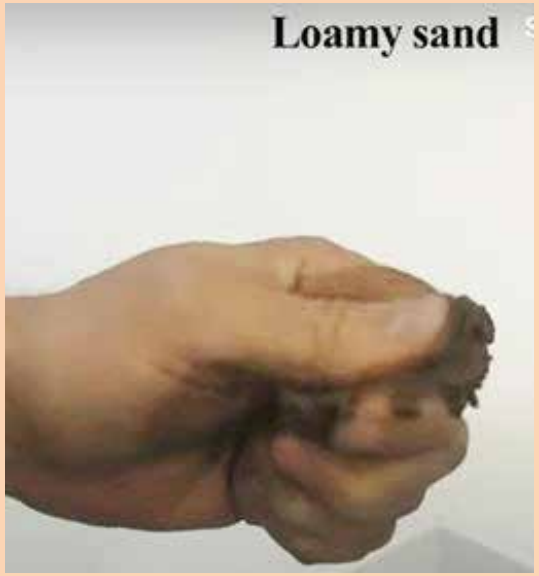
Cohesionless soils

- Sand <5% clay - nil coherence

Particles do not stick together, relying primarily on friction between particles for strength. They will not form a ribbon.

Loamy sand – Slightly coherent

- Loamy sand, clayey sand - 5-10% clay (slightly coherent)



- Sandy loam - 10 – 20% clay (coherent)

Dominant Size of sand particles

- Fine (0.02 - 0.2mm) ASC
- Medium – FAO, USDA, Unified sizes are all different
- Coarse (0.2 – 2mm) ASC
- Mixed sizes- terminology varies with discipline????
  - Well sorted sand is the same size (Sedimentology)
  - Well graded sand is of mixed sizes (Engineers- Unified)

Shape and roughness of sand particles

- Varies according to parent material, weathering and transportation
- Angularity v roughness v roundness
- Differences impact agriculture and industrial use

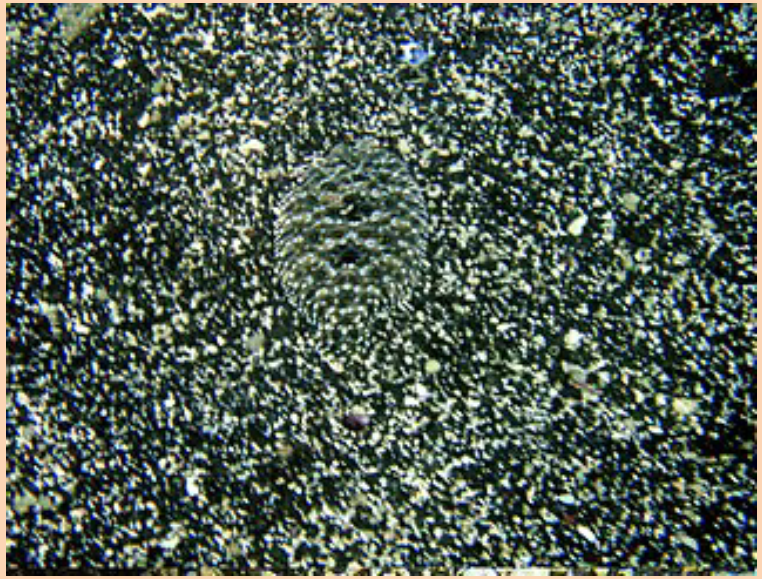
Source: Wikipedia commons

Mineralogy of sand particles

- Counted 9 main classes of minerals
  - Quartz (most common - inert)
  - Carbonate, primary minerals (light and heavy fractions, rock, oxides)

Quartz

Calcareous



Basalt

Source: Wikipedia commons

Coatings on sand particles

- Carbonates
- Sesquioxides – significant agents of colour
- Ferromanganiferous and manganiferous minerals
- Silicate clays – clayey sand field texture
- Organic matter - loamy sand field texture
- Amorphous silica
- Gypsum, other salts

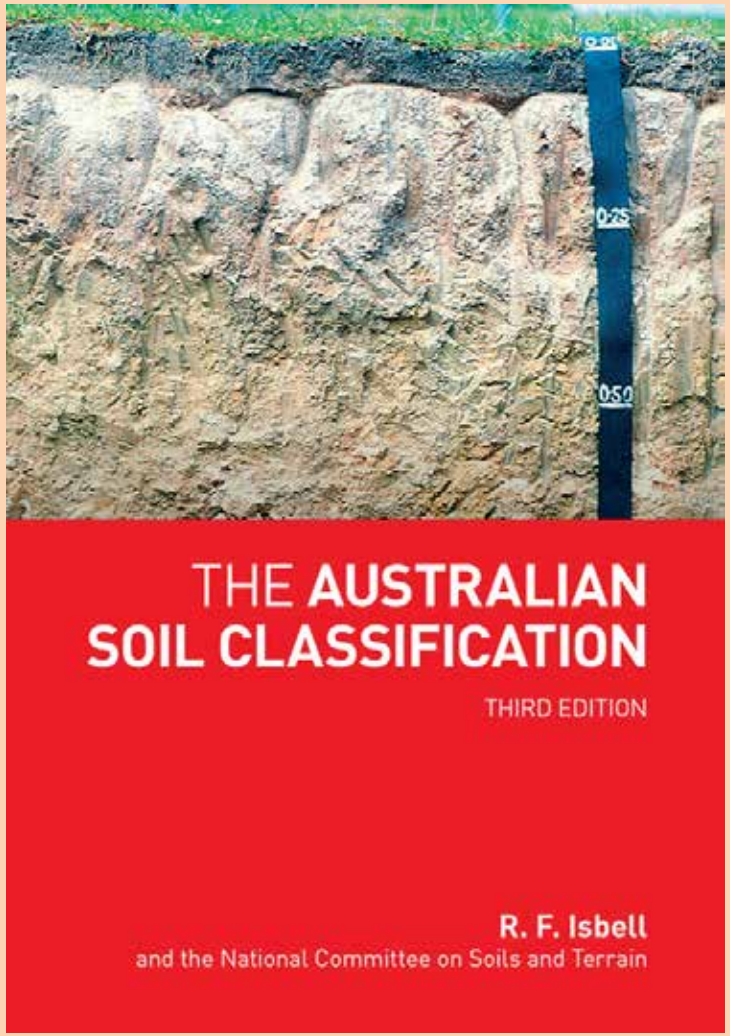
Possible cementing agents – can accumulate to form pans

Presence or absence usually determines soil colour

What do most sand particles have in common?

- **Not their size, shape, mineralogy or coatings!**
- Little or no surface charge
- Little nutrient supply or retention (sesquioxides – P)
- Low plant available water capacity
- Have reasonable porosity – fast drainage
- They need help to grow healthy plants
- Vulnerable to wind erosion

The Australian Soil Classification



Is available on the web.

https://www.soilscienceaustralia.org.au/asc/

Soil orders can be viewed on a poster

https://www.soilscienceaustralia.org.au/asc/soilposter.htm

Classification attempts to cover the whole universe of soils found in Australia, including all sandy soils.

Recent History of the Australian Soil Classification
With respect to sandy soils

1996 - 2021

There were **14** soil orders in Australia

Sand soil textures of A and B horizons dealt with at the family level, the lowest level

Deep sands were represented in the **Podosols** and **Arenic** versions of **Rudosols** and **Tenosols** soil orders, which are highly variable.

2022+ (third edition) (key of 110 pages)

A new soil order, the **Arenosols** was introduced where **deep sands** were placed,. They replaced the deep versions Arenic Rudosols and Arenic Tenosols. **Water repellence** was also introduced as a new family level criteria.

The Arenosols key takes up 9 pages

11 suborders, 42 Great Groups, 13 Subgroups and 5 Family criteria

Simplified key to the Soil Orders

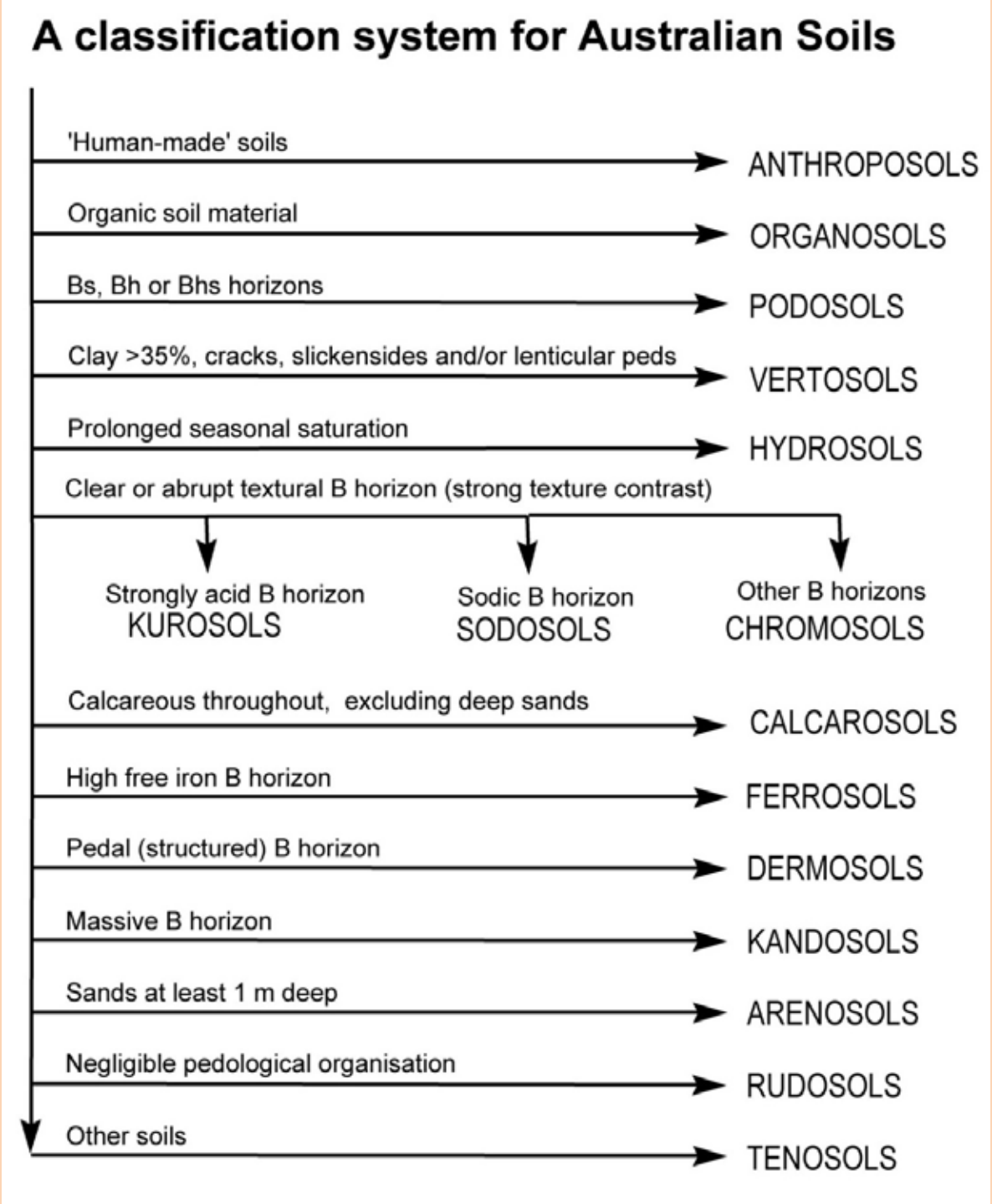
The ASC is a **general purpose**, hierarchical scheme, consisting of **Orders, Sub-orders, Great groups, Sub-groups,** and **Families**.

A simplified key to the highest level in the **hierarchy (Soil Order)** is shown here

There are **15** different soil orders in Australia.

Arenosols and Podosols are always sandy.

12 other soil orders may have members that may have sandy horizons.



Sandy soil properties directly addressed by ASC

- **Soil depth**
  - Sand>1m deep, **Arenosols**
  - Sand <1m deep over rock etc - Suborder of **Rudosols**, Great Group of **Tenosols**
  - Sands with Bhs horizons - **Podosols** (indirect, commonly deep, some giant)
  - Soil depth - Family level criteria all soils
  - A horizon thickness and A & B horizon texture - Family level criteria all soils
- **Water repellence**
  - Family level criteria most soils
- **Presence of gravel**
  - Family level criteria all soils

Sandy soil properties directly addressed by ASC

- **Mineralogy** –implied to be quartzitic, unless
  - Calcareous sands
  - Gypsic sands
  - Sulfidic sands
  - Tephric sands (pyroclastic – volcanic)
  - Gravic sands (heavy minerals present)
- **Others**
  - Colour, surface organic matter, salinity, pH catered for
  - Arenosols allow for minor non-sandy horizons - sandy loams, gravels, accumulations, substrate properties
  - Arenosols may have subsets of particle size (<5% and 5-10% clay)

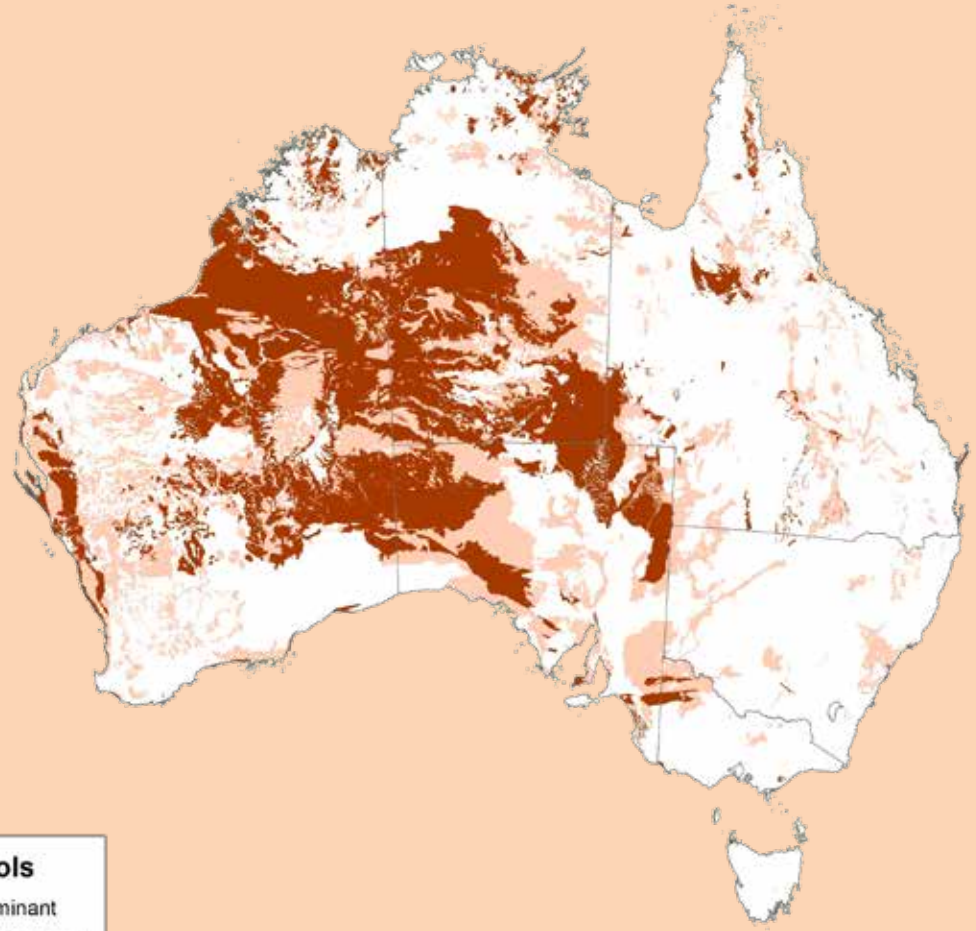
Sandy soil properties not addressed by ASC

- Particle size distribution of sand
  - Fine, medium, coarse, mixed (not sorted)
- Mineralogy –
  - Basaltic sands (indirect with colour class)
  - Primary minerals (light fraction)
  - Coatings – some indirect with colour classes only
- Shape and roughness of sand (excluding gritty)
- Naturally hardsetting subsoil sand (but only when dry)
  - May explain variable response to deep ripping

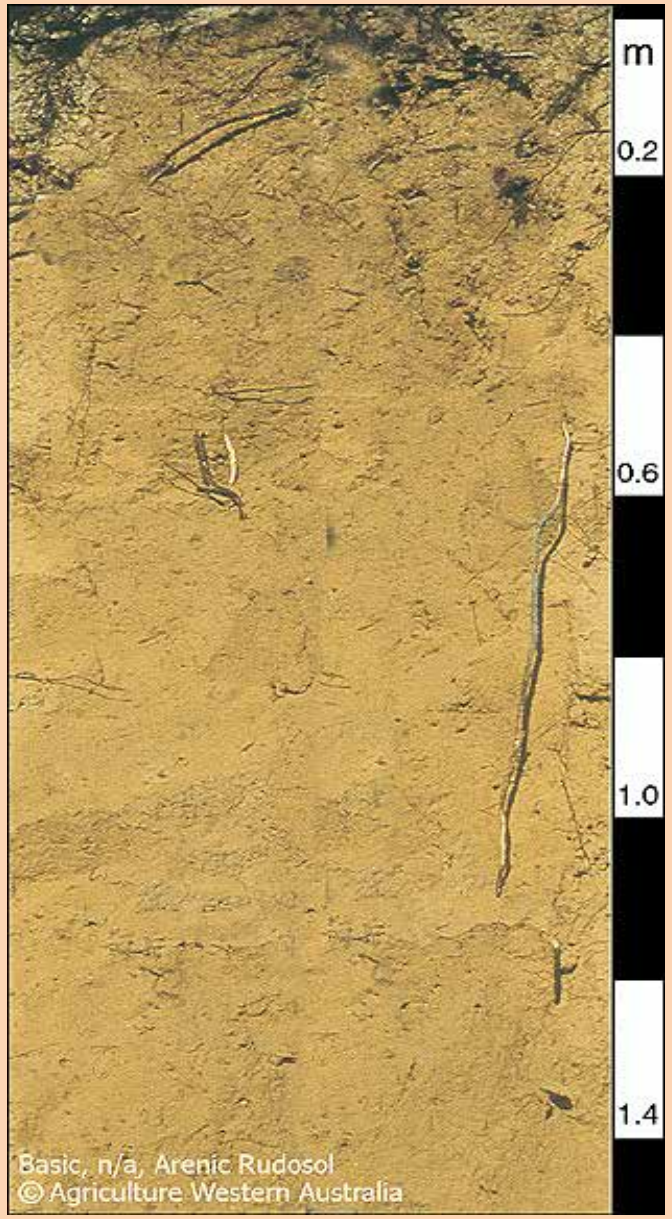
Sandy soil classifications P

Soil property	WRB	Soil Taxonomy	ASC
Sand size	0.0625 – 2mm	0.05 – 2mm	0.02-2mm
Deep sands	Soil order Arenosols >1m deep	**Suborder** Psamments (general)	**Soil order** Arenosols >1m deep
Shallow sands	Arenic qualifier	Subgroup Arenic	Arenic Suborder or Great Group
Wet sands	Arenic Gleysols	Great group Psammaquents	Arenosolic Hydrosol
Texture of soil horizons	Areninovic qualifier Epiarenic subqualifier	Sandy texture at Family level (Aniso)	A horizon texture and B horizon maximum texture at Family level
Other properties	Mineralogy qualifiers	Mineralogy, clay coatings at Family level	Mineralogy at Suborder and Great Group level

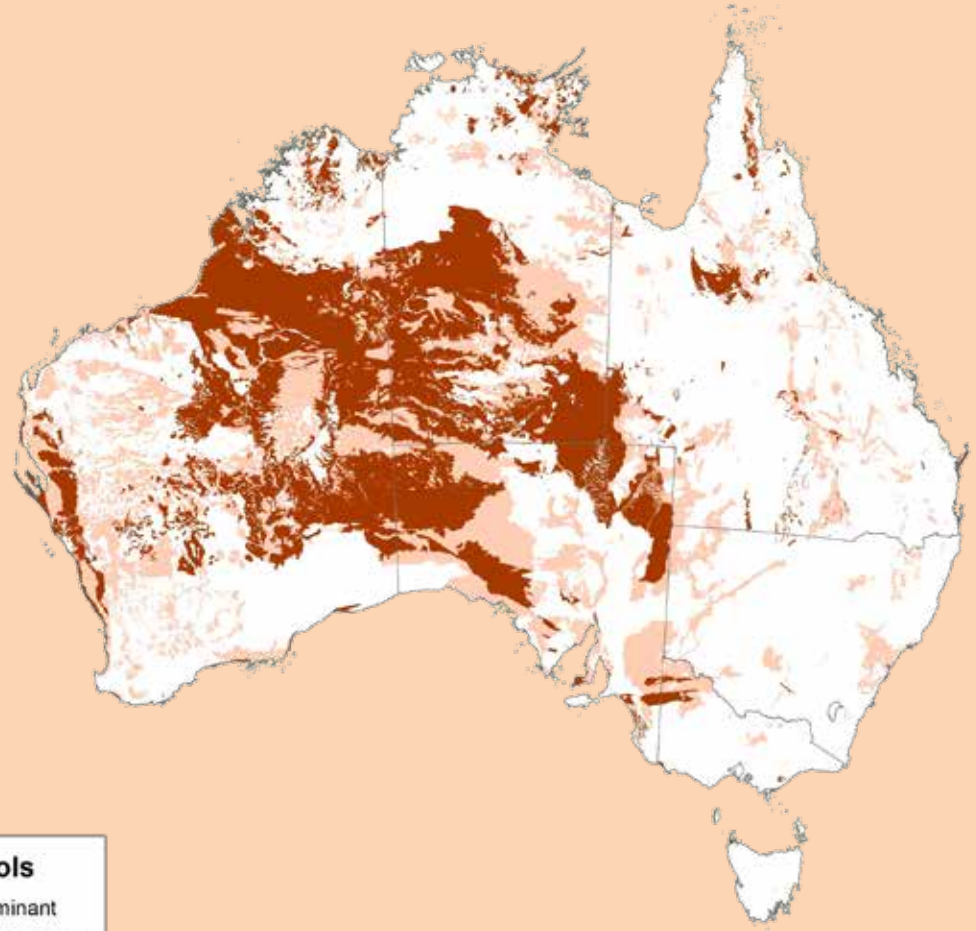
Arenosols



Sandy textured soils at least 1m deep. Many are stratified and some are formed or degraded by wind erosion.



Arenosols



Sandy textured soils at least 1m deep. Many are stratified and some are formed or degraded by wind erosion.

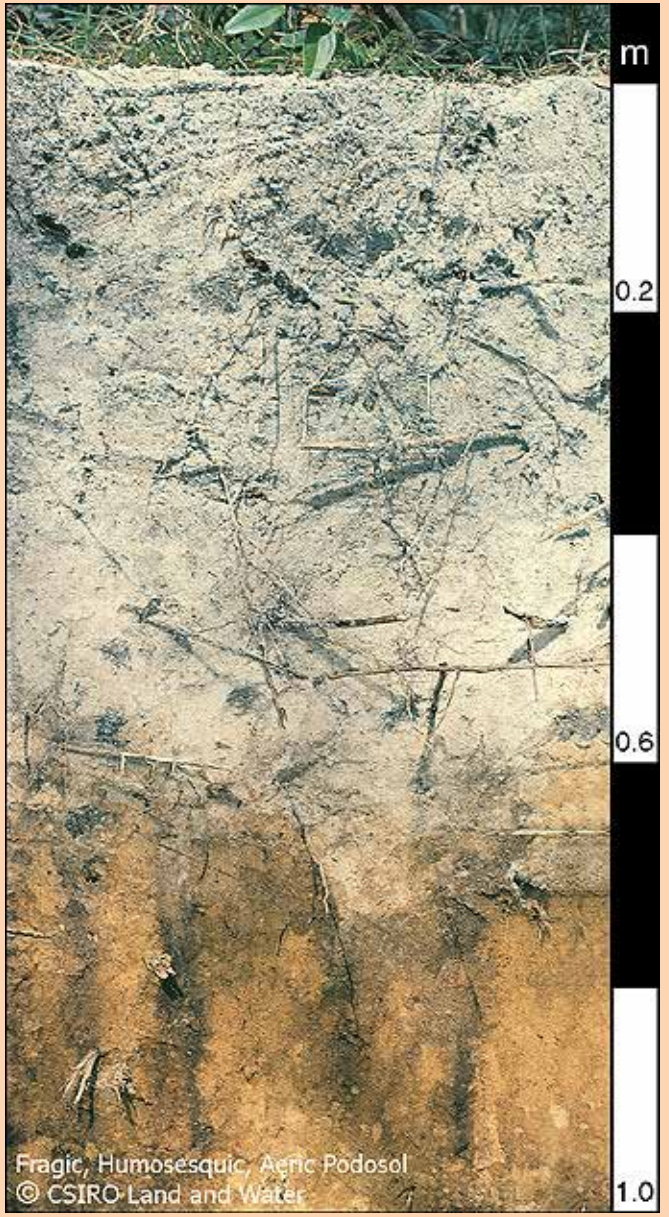
The Arenosols Soil order (sands > 1 m deep)

- Deep sands are the most extensive soil type in Australia and are quite diverse (82 subclasses).

- They are extensively used for Agriculture in WA and SA, but prone to wind erosion, water repellence and soil acidification.

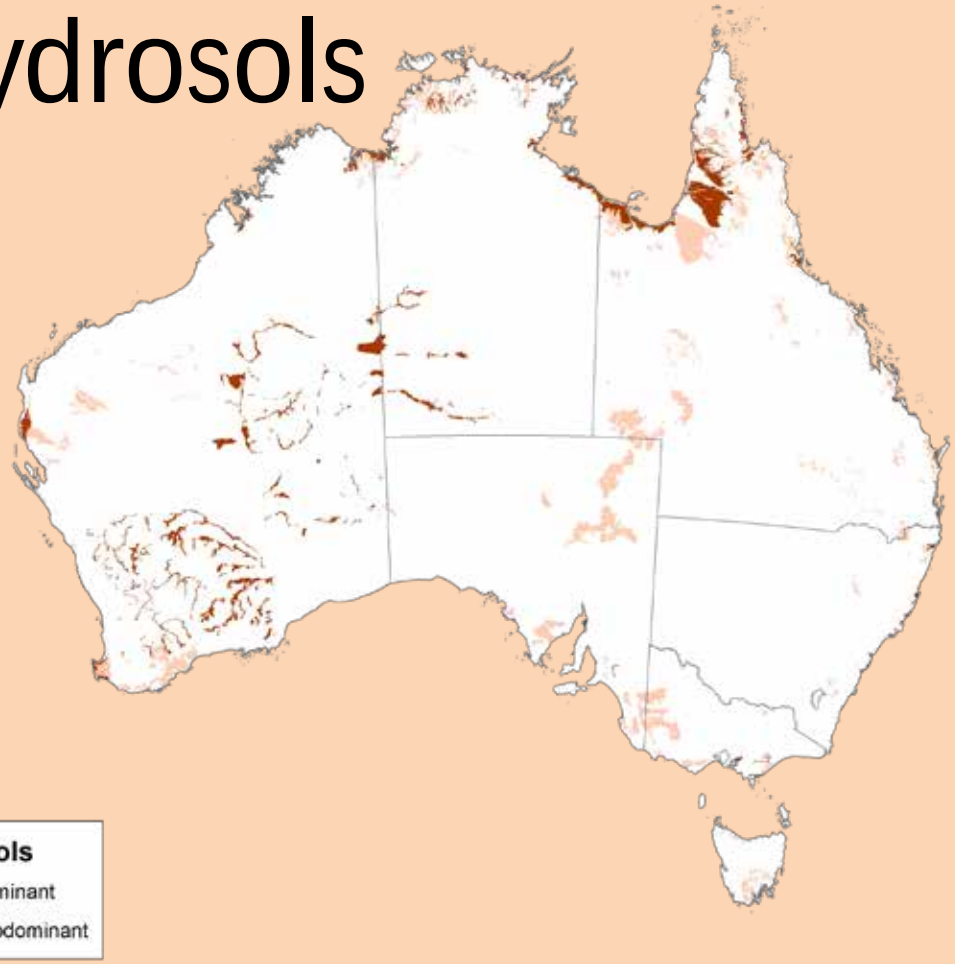
- They are important sources of heavy minerals and industrial sand.
- Their high porosity has significance for landscape hydrology and as a groundwater resource

Podosols



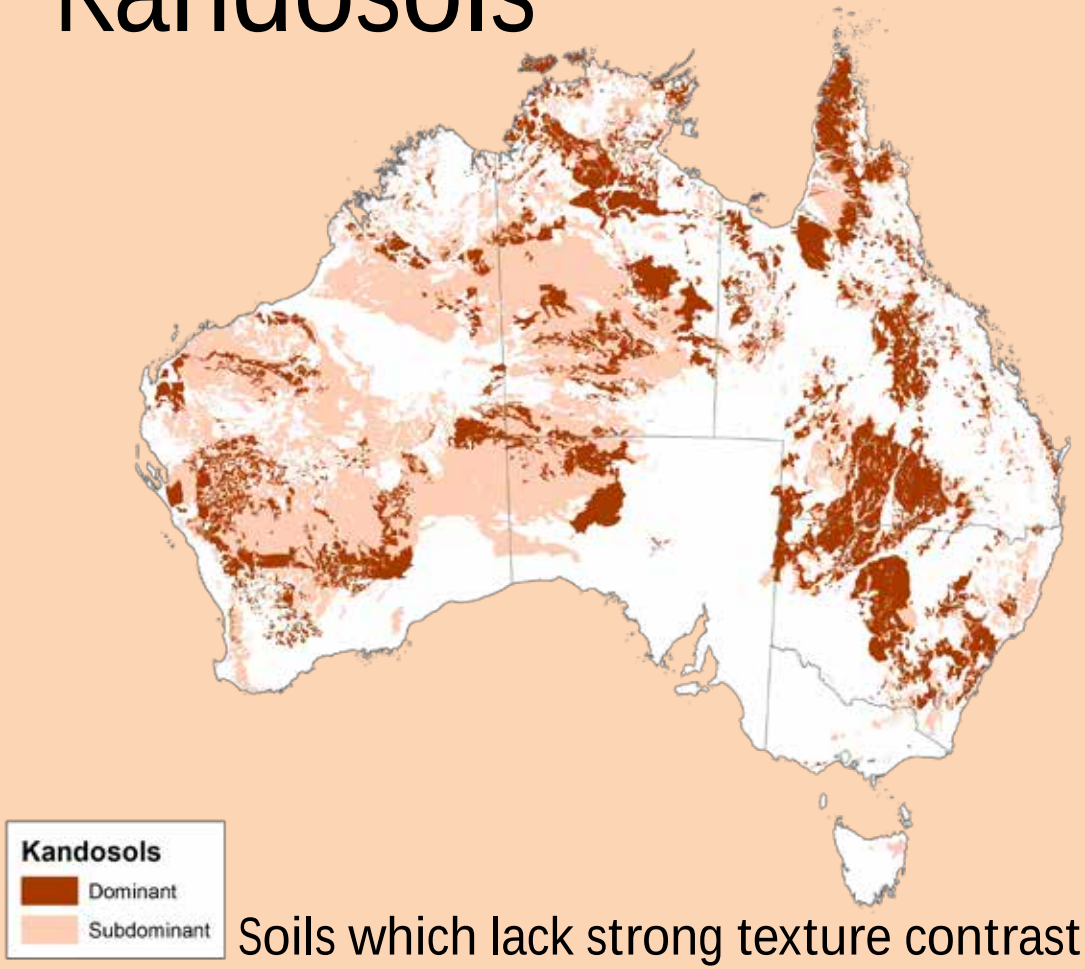
Soils with B horizons dominated by the accumulation of compounds of organic matter, aluminium and/or iron. These soils are recognised world-wide, and Australia is particularly noted for its 'giant' forms.

Hydrosols

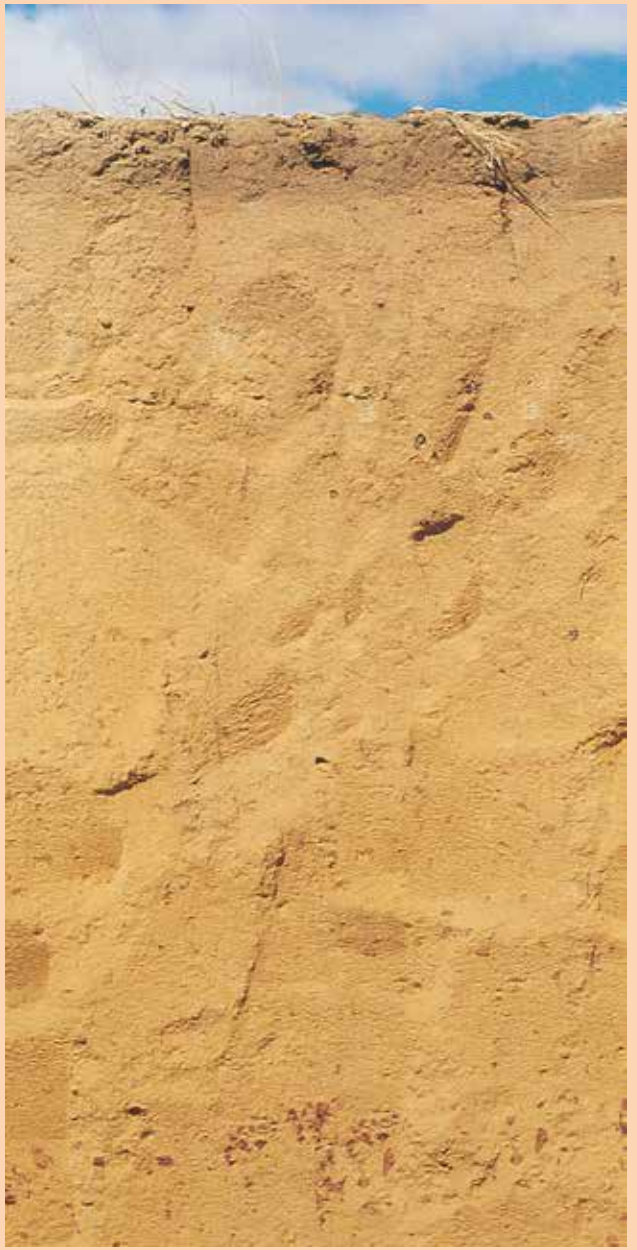


A range of seasonally or permanently wet soils and thus there is some diversity within the order. The key criterion **is saturation of the greater part of the profile for prolonged periods (2-3 months) in most years**. Evidence of reduction and oxidation such as 'gley' colours and ochrous mottles may or may not be present.

Kandosols



Soils which lack strong texture contrast, have massive or only weakly structured B horizons, and are not calcareous throughout. The soils of this order range throughout the continent, often occurring locally as very large areas.

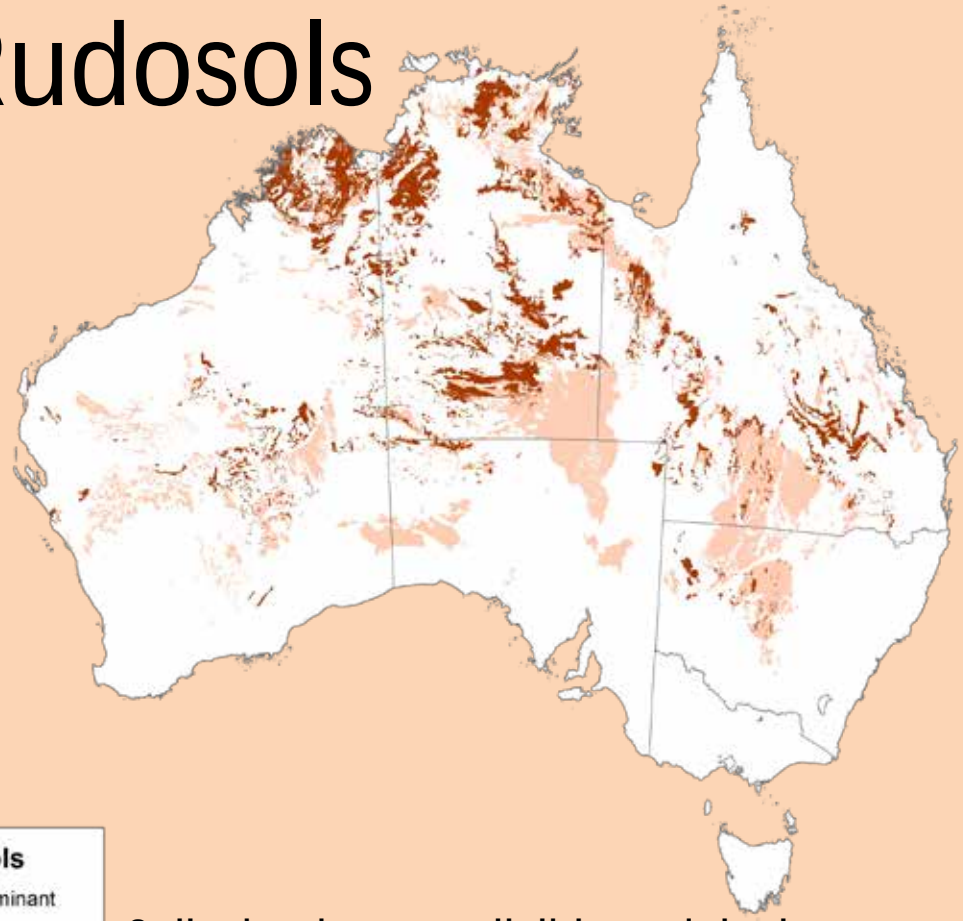


Organosols

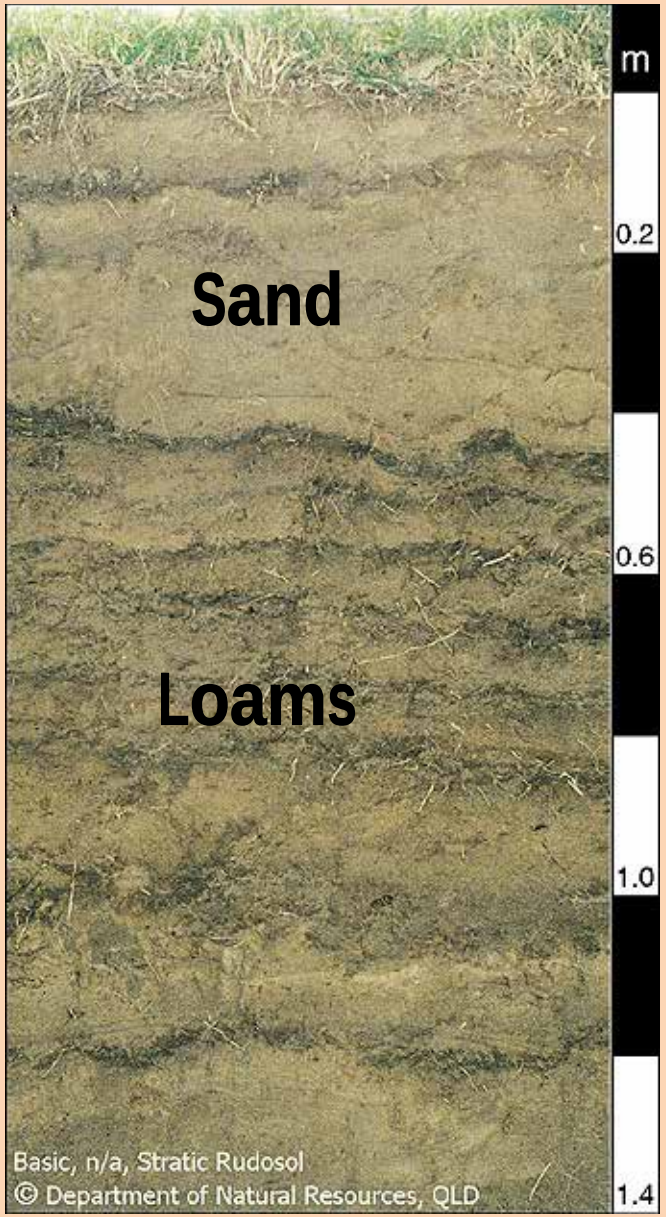
Soils dominated by organic materials. Although they are found from the wet tropics to the alpine regions, areas are mostly small except in south west Tasmania. The persistent wet and anaerobic conditions slow decomposition allowing organics to accumulate

Source: Rob Moreton, DNRE, Tasmania

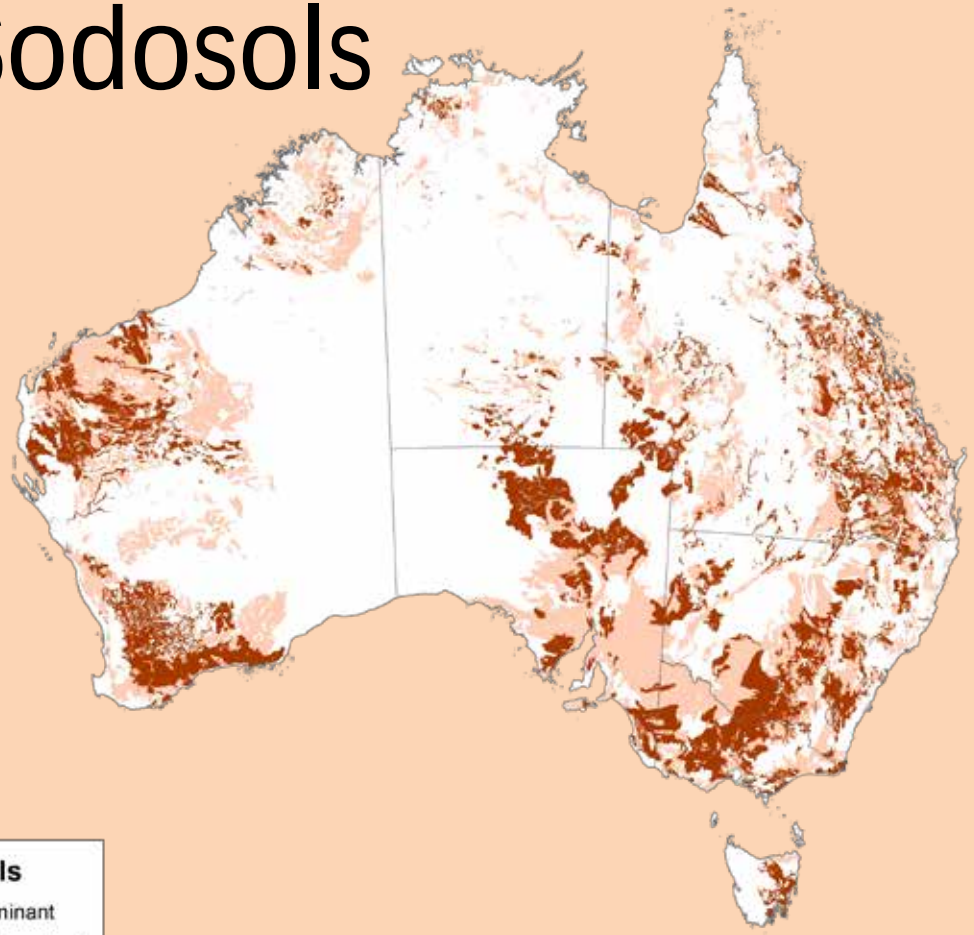
Rudosols



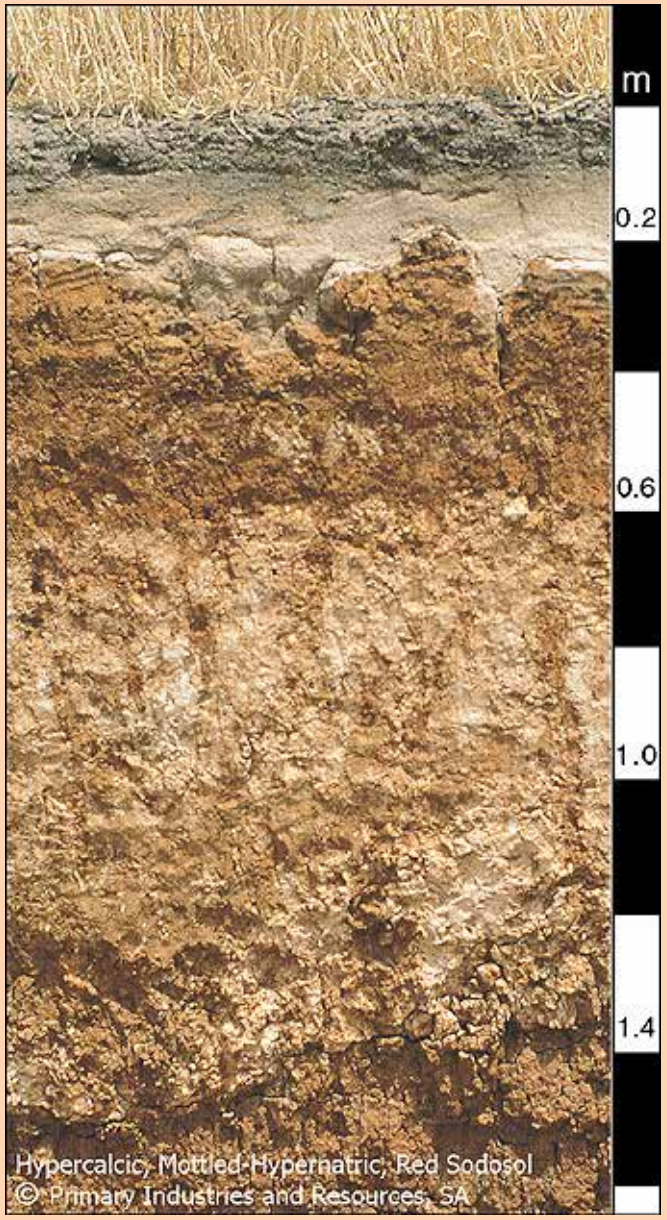
Soils that have negligible pedologic organisation. They are usually young soils in the sense that soil forming factors have had little time to pedologically modify parent rocks or sediments. The component soils can obviously vary widely in terms of texture and depth; many are stratified and some are highly saline.



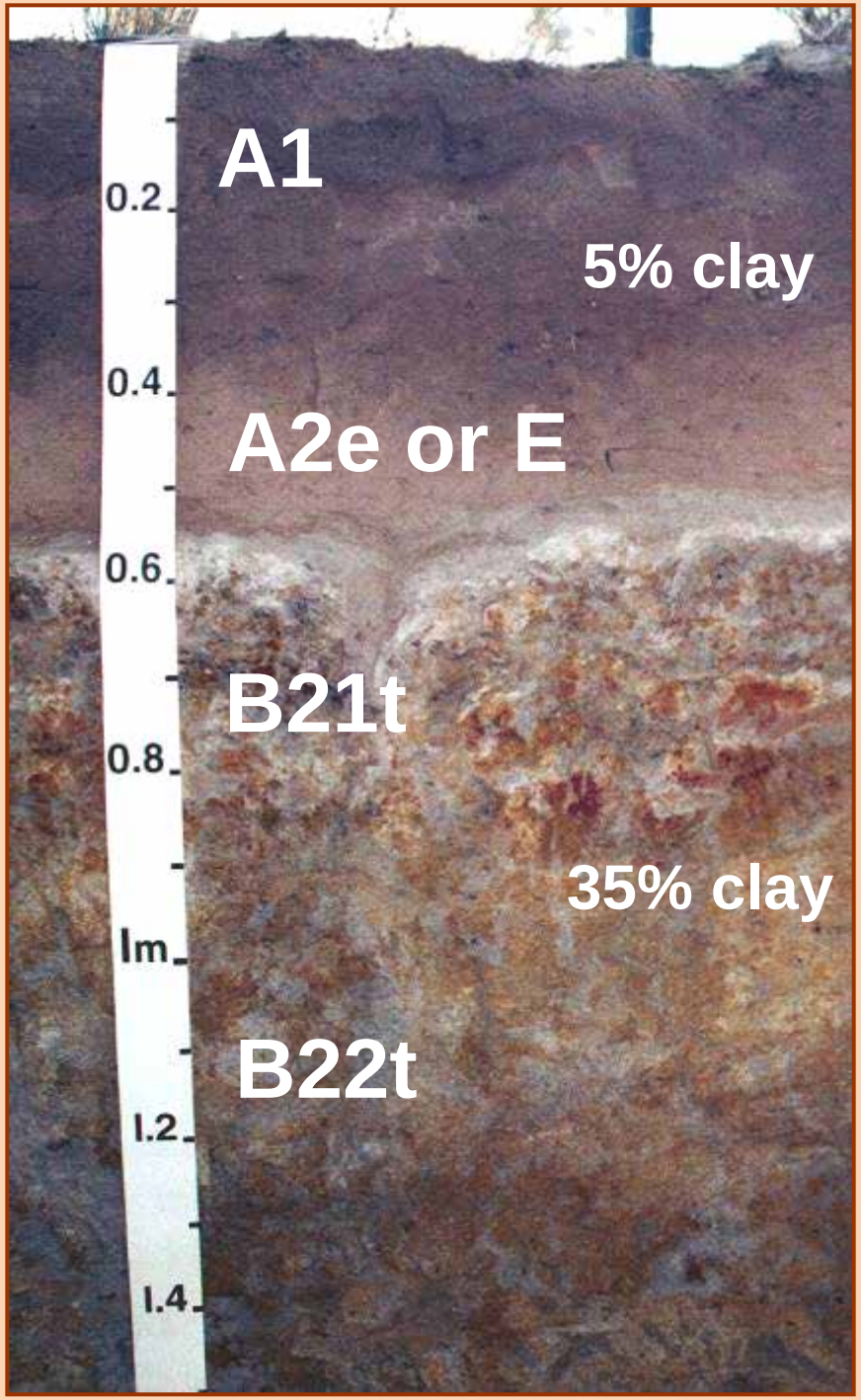
Sodosols



Soils with strong texture contrast between A horizons and sodic B horizons which are not strongly acid. Australia is noteworthy for the extent and diversity of sodic soils and the use of sodicity in Australian soil classification.



Sodosol



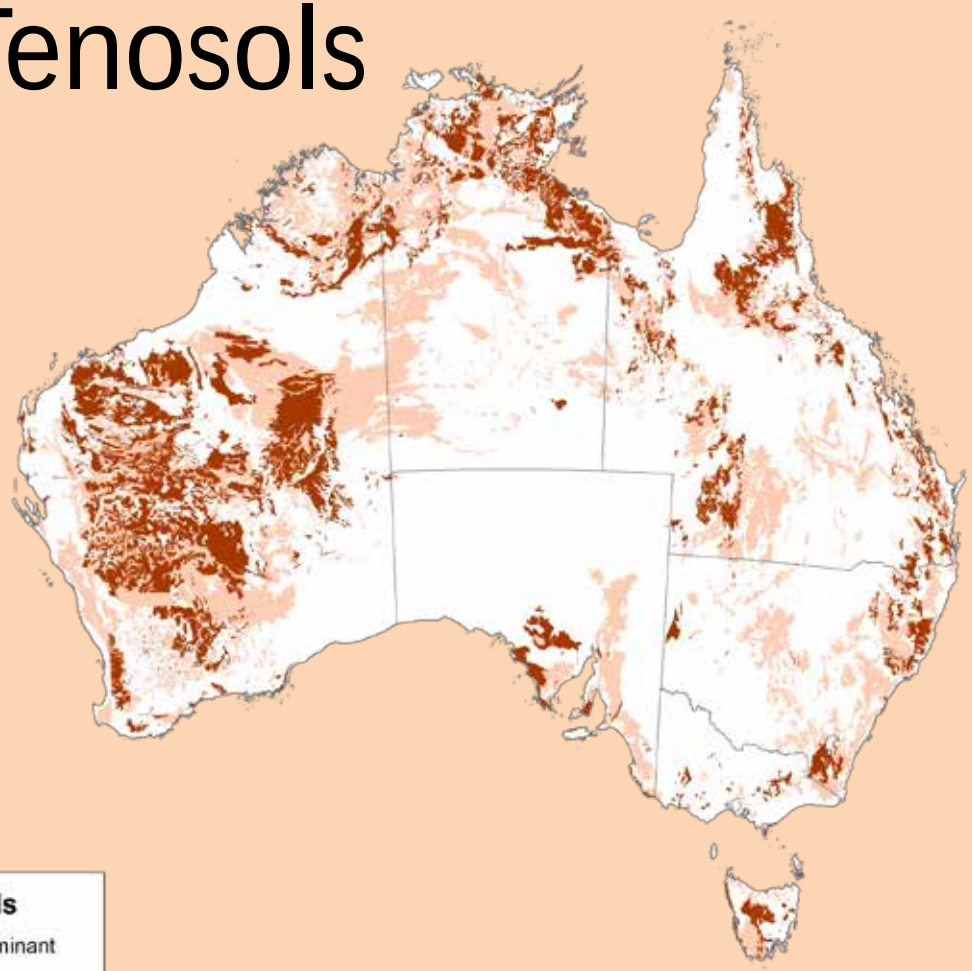
Loamy sand - massive

Loamy sand - bleached

Hard clay - columnar

Hard clay - massive

Tenosols



Soils with generally only weak pedologic organisation apart from the A horizons. It encompasses a rather diverse range of soils, which are nevertheless widespread in many parts of Australia.

TAKE HOME MESSAGES

- Particle size ranges and sandy soil concepts are very diverse
- The ASC covers much of this diversity and was improved substantially with the introduction of the Arenosols soil order
- The ASC has promoted a useful vocabulary and consistent meaning for sandy soil profiles and horizons
- When investigating and reporting on sandy soils, be as specific as possible (perhaps use the ASC or your preferred classification)
- Ask yourself, “Where do my sandy soils fit?”