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The Geology and Soils of the Southern Alice Springs District

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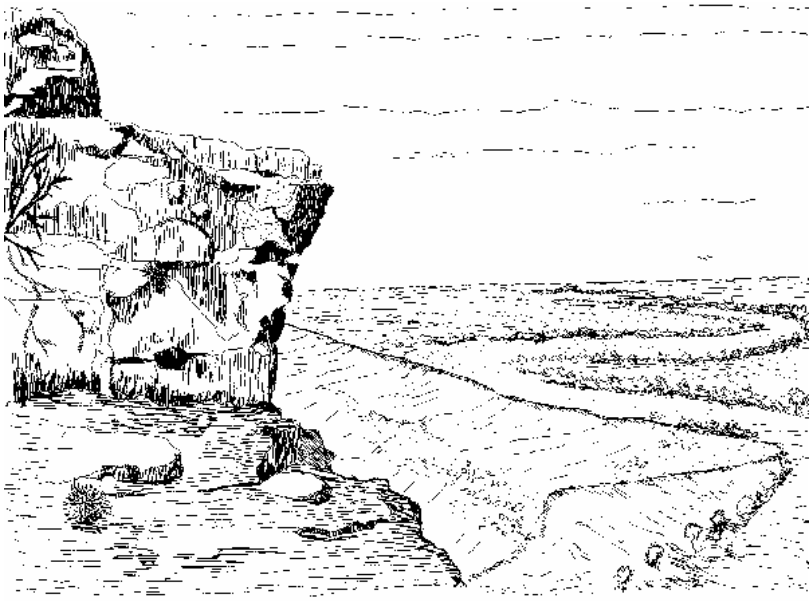
GEOLOGY AND GEOMORPHOLOGY

The area comprises three geological structural units. The major unit is the eastern Amadeus Basin which is bounded on the north by the Arunta (geological) Block and in the south and south-east by the Musgrave (geological) Block.

The physical features of the landscape have evolved over a period exceeding 2000 million years. The oldest features are the Arunta and Musgrave Blocks in which the basement of the continent is exposed as metamorphic rocks (rocks that have been changed by heat and pressure). Compression of the earth's crust and mountain building in very early history (2000 million to 1200 million years ago) formed rigid block partly exposed as the Chewings Ranges in the north and the Ayers Ranges in the south. Against these blocks, younger rock strata have in turn been folded. The Amadeus Basin lies between these blocks.



Over a period of 900 million years the Amadeus Basin has experienced a broad spectrum of climates, with sediments being laid down during periods of inundation under seas and lakes and, during terrestrial episodes, by river systems.

Periods of extreme erosion and rapid accumulation of sands gave rise to quartzites and sandstones, now exposed in the mountains of the region, with slower deposition of muds and organic layers being compressed into siltstones and limestones. During these periods of sedimentation, distortion of the earth's crust intermittently occurred resulting in uplifting, downwarping and compression of the surface crust culminating in the building of ranges.

This occurred during climatic periods either more humid or colder than the present and rapid erosion following these events then reduced the land surface to a near plain. Erosion later slowed and silcrete (hard calcium carbonate) cappings formed in some places. This was then followed by gentle uplift.

More recent erosion has now dissected most of the silcrete capped plains leaving some small remnants such as the Rumbalara Ranges and scattered low mesas throughout most of the region.

Over the period 65 million years to 1 million years before the present, the climate became progressively more arid, (although it was interrupted by short wetter periods during that time). Lakes and rivers dried up approximately 1 million years ago. Subsequently, when the climate was much more arid than at present, sand dunes developed.

The climate then became slowly less arid again and further erosion and dissection occurred with deposition of alluvium. Alluvial soils and red earth soils were formed at this time whilst the sands of the dunes and sand plains were stabilised by vegetation. The major geological events of the region are summarised in Table 1.

The geology of the area has been described in detail by Wells et al. (1970) and in the 1:250,000 Geological Series Explanatory Notes for each map sheet (Cook, 1968; and Cook, 1969; Stewart, 1967; Wells, 1969; and Shaw and Wells, 1983).

SOILS

General Soil Characteristics

Parent material, climatic history and landform are the factors determining the nature of soils. There is only moderate correlation between soils and vegetation with some soil groups always supporting a particular pasture type (vegetation association) whilst others may support two or more distinct plant communities (Jackson, 1962).

Several broad generalisations can be made about soils in the region. They almost invariably exhibit low inherent fertility characterised by low cation exchange capacities (cation exchange governs stability of soil structure, soil pH and the availability of nutrients to plants) and low levels of phosphorus, nitrogen, potassium, sulphur and organic carbon.

Virtually all the soils exhibit poor profile development, (poor profile development indicates paucity of the fertile surface layers), whilst older soils, especially the red earths and red clayed sands, have been extensively leached during an earlier, more humid erosion cycle. These soils usually support spinifex or mulga communities.

Whilst the red earths and red clayey sands exhibit neutral or slightly acid soil reaction, large areas supporting more productive pastures have calcareous soils or comprise younger alluviums with alkaline soil reaction.

Table 1. Geological history of the southern Alice Springs district (NT Geological Survey,1984)

Geological period	Time (millions of years ago)	Event
Quaternary	2 to present	Development of soil and sand cover.
Tertiary	65 to 2	Valleys filled with fresh water lakes; much silt and clay sediment deposited.
Devonion to Carboniferous	about 350	Alice Springs mountain formation; accompanying folding and faulting of the rocks. Deposition of much sand and conglomerate occurred initially.
Adelaidean to Devonion	850 to 400	Amadeus Basin covered by sea deposition of sand, silt, mud, lime mud and rare glacial sediments. After the Cambrian (570 million years ago), these beds included fossils.
Lower Proterozoic	about 2,000	Deposition of sedimentary and volcanic rocks, then metamorphism and intrusion by igneous rocks to form present day Arunta and Musgrave Blocks.

The calcareous soils (containing calcium carbonate) usually contain calcrete or they overlie limestone and dolomite parent rocks at shallow depths. These soils have been stripped of the original soil surface and vegetation comprises an open witchetty bush, shrubland or southern bluebush chenopod shrubland.

Alkaline alluviums are young soils which reflect the calcareous nature of the parent material. These alluviums grow mainly open woodland type communities.

Smaller areas of red brown stony clayey soils occur on plains and gentle hill slopes. The soil surface is mantled with silcrete gravel and stones. Small gilgaied, red or grey, clay soil swamps grow northern bluebush or bladder saltbush and small claypans with non-gilgaied red clays also occur (gilgaied soils occur when swelling and shrinking of heavy clays cause numerous depressions on the soil surface). Very saline clays and gypseous and calcareous sands are restricted to salt pans, salt lakes and saltpan fringes.

Soil Groups

Characteristics of the seven broad soil groups in the area are summarised below.

i) Alluvial Soils

These soils occur on floodplains and alluvial fans and encompass a range of textures from sands to clays. Silt content is high. They are characteristically brown or reddish brown in colour, slightly acid and non-calcareous. The coarser textured soils have a severe wind erosion potential but 'claypan' deposits are quire stable.

ii) Shallow, Stony, Undifferentiated Soils (Lithosols)

Shallow, poorly-developed soils occurring on the ranges and low outcrops where soil development is limited by slope. Disturbed soils may scour with storm runoff.

iii) Red Sands and Clayey Sands

Deep red sands and clayey sands are the dominant soils of spinifex sand plains and dune fields. Shallow sandy soils usually overlie crystalline sandstones. These soils are generally well-vegetated but have a slight risk of wind drift and dune activation in droughts.

iv) Red Earths

Red earth soils are deep reddish brown, sandy clay loams often increasing slightly in texture with depth. Red earth soils mainly occur within mulga woodland communities. They are generally stable or slightly susceptible to wind sheeting and water sheeting.

v) Calcareous Earths

These soils are alkaline sandy clay loams with increasing calcrete at depth. These soils usually grow palatable pastures dominated by oat grasses with lesser amounts of copperburrs and sidas. Shallow calcareous earths overlaying limestone or dolomite usually grow witchetty bush, whilst deeper red calcareous earths grow gidyea to the east of Alice Springs or myall in the far south. Calcareous earths are moderately susceptible to wind sheeting and erosion by water.

vi) Texture Contrast Soils

Texture-contrast soils feature an abrupt transition from a coarse or medium-textured and slightly acid surface to a clayey and often saline and alkaline subsoil. These soils are very prone to scalding, whereby the sandy surface is lost through erosion, exposing a sealed clayey surface that restricts infiltration and prevents revegetation.

vii) Coarse Structured Clay Soils

Coarse structured clay soils are usually alkaline and gilgaied. Soil depth is variable. On erosional slopes they are quite shallow and stoney and overlay sandstone and siltstone. Shallow clay soils are often saline and prone to water erosion. Deeper clay soils are stable and occur in swamps and internal drainage depressions.

viii) Saline and Gypseous Soils

These generally stable soils are restricted to salt pan areas. Saline clays are reddish grey in colour and are often water-logged. Gypseous soils are light reddish brown sands and loamy sands.

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