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# Geology and mineral resources of the Northern Territory

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## Chapter 20: Fitzmaurice Basin

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# Chapter 20: FITZMAURICE BASIN

**JN Dunster**

## INTRODUCTION

The newly named Fitzmaurice Basin in the northwestern Northern Territory contains the Fitzmaurice Group (**Figures 20.1**, **20.2**). This enigmatic group is a succession of unmetamorphosed siliciclastic, dominantly arenaceous sedimentary rocks, probably in excess of 3500 m thick. The stratigraphic succession of the Fitzmaurice Group is summarised in **Figure 20.3**. The group consists of four formations in the Northern Territory and is exposed in a northeast-trending structural belt from near the Western Australian border to north of Daly River (**Figure 20.2**). The formation names were introduced by Sweet *et al* (1974) who assigned them to the Precambrian, but not to any particular basin. Much of the following discussion is based on Sweet's original work and from subsequent mapping undertaken in the north (Edgoose *et al* 1989). It is difficult to distinguish between the formations on the ground, because of lithological similarity, subtle lateral facies changes, the lack of marker beds or diagnostic sedimentary structures, and structural complexity, including fault-repetition. Furthermore, it is probable that the previously presented, conformable layer-cake stratigraphic succession is a simplification, especially when regional-scale relationships are considered. There are no unequivocal chronostratigraphic ages from the Fitzmaurice Group. A Palaeoproterozoic or Mesoproterozoic age has been inferred from the ages of underlying basement and from intrusive rocks. The group commonly forms inaccessible, steep rugged benches, scarps and ridges and this has hindered further work. Dunster *et al* (2000) suggested that the structural affinities are with the Halls Creek Orogen and that there is little stratigraphic similarity with basins to the east (eg Victoria and Birrindudu basins), but further work is required to clarify its lithostratigraphic affinities. Possible correlatives include any of several Palaeoproterozoic groups in Western Australia (eg Speewah, Kimberley groups), any of several elements of the Birrindudu Basin, or the Carr Boyd Group in its namesake basin along trend in Western Australia. Indeed, the Fitzmaurice Basin may contain more than one correlative from elsewhere (eg both Palaeoproterozoic and Mesoproterozoic successions that are equivalent to both the Birrindudu or Limbunya groups and the Carr Boyd Group).

A maximum depositional age of 1640 Ma has been obtained from detrital zircons in the Moyle River Formation of the Fitzmaurice Group (Chris Carson, Geoscience Australia, pers comm 2009). The latter would suggest a correlation with the ca 1640 Ma Limbunya Group or younger groups of the Birrindudu Basin. The thick siliciclastic rocks of the Fitzmaurice Group have no direct lithostratigraphic correlative in the predominantly carbonate and evaporitic Limbunya Group. Although some of the younger groups in the Birrindudu Basin are dominantly clastic, their combined total thickness is less than that of just the basal sandstone formation in the Fitzmaurice Group. This would suggest that if the Fitzmaurice Group was deposited contemporaneously with the ca 1640 Ma elements of the Birrindudu Basin, it was in a very different basinal setting.

The overall similarity with the Carr Boyd Basin in Western Australia is that both unconformably overlie the same basement and contain >3000 m of dominantly siliciclastic sedimentary rocks comprising fine- to coarse-grained quartz sandstone, siltstone, and minor lithic sandstone and conglomerate. The basins occupy similar structural settings and the environments of deposition appear to be similar. The correlation between the Carr

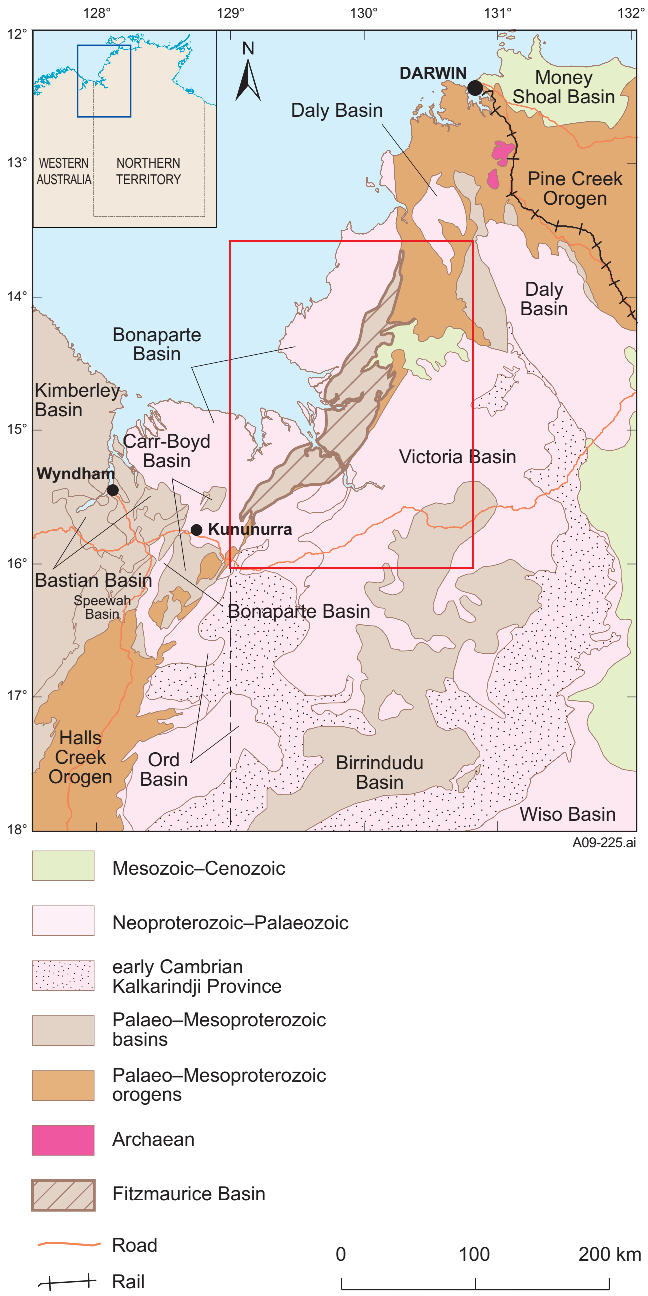


**Figure 20.1**. Regional geology of Fitzmaurice Basin. NT geological regions from NTGS 1:2.5M geological regions GIS dataset. WA geological regions simplified and slightly modified from Tyler and Hocking (2001); some small outliers/inliers omitted. Extent of Kalkarindji Province in WA slightly modified from Glass and Phillips (2006). Red box shows location of **Figure 20.2**.

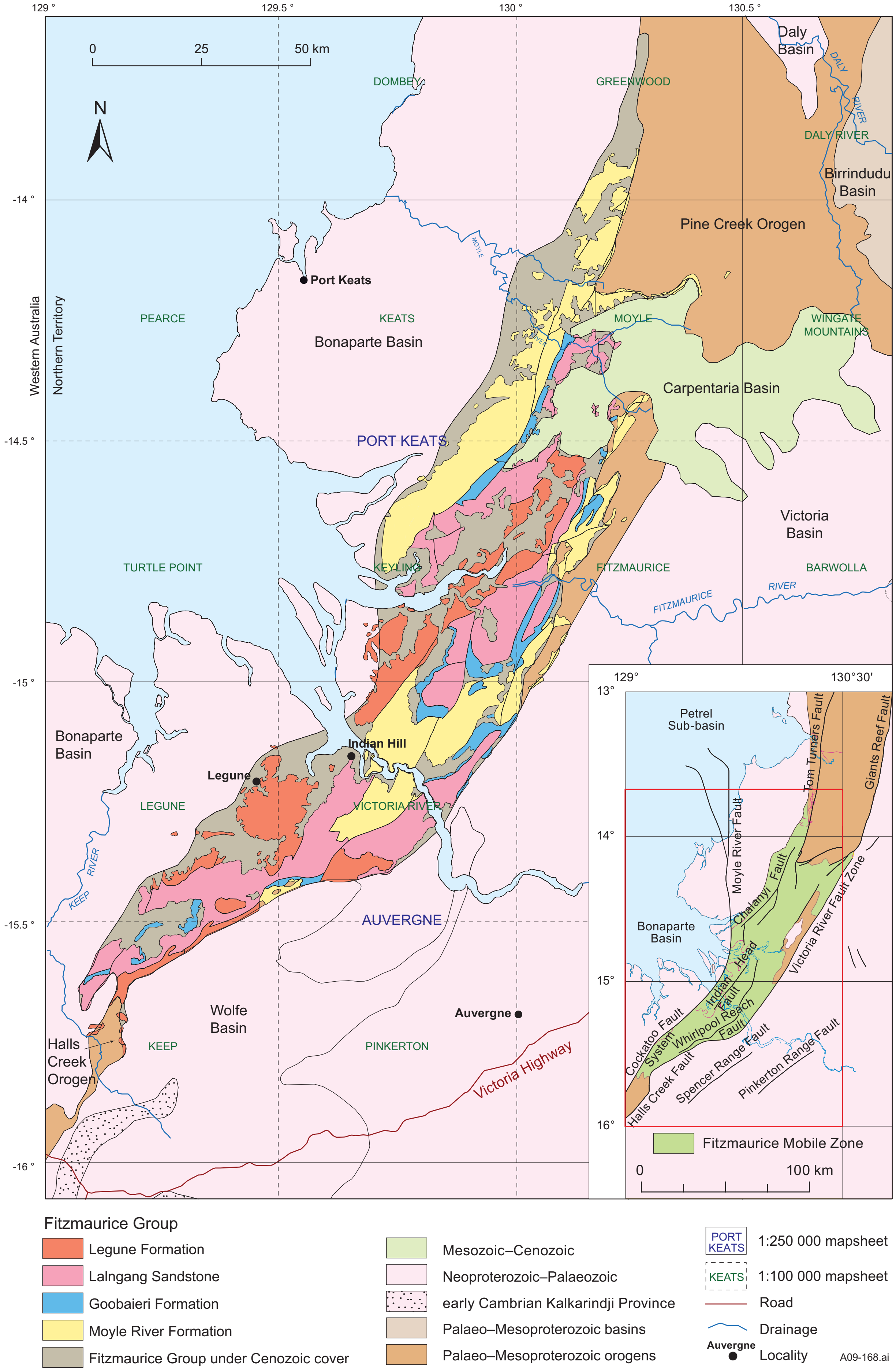


**Figure 20.2**. Fitzmaurice Basin, showing simplified geology of the Fitzmaurice Group, derived from GA 1:1M geology and NTGS 1:2.5M geological regions GIS datasets. Inset shows major faults of Fitzmaurice Mobile Zone. Location shown in **Figure 20.1**.

Boyd Group and the Fitzmaurice Group was first suggested during Bureau of Mineral Resources mapping in the 1970s (eg Morgan 1972). Sweet *et al* (1974, written comm 2009) and Thorne *et al* (1999) correlated the Stonewall Sandstone and Pincombe Formation of the upper Carr Boyd Group directly with the Lalngang Sandstone and Legune Formation in the upper part of the Fitzmaurice Group (**Figure 20.3**). However, the sandstone units in the Fitzmaurice Group are much thicker than those in the Carr Boyd Group and have a wider range of sedimentological maturity. The Carr Boyd Group is thought to be Mesoproterozoic. The closest outcrops of the Carr Boyd Group in CAMBRIDGE GULF[1] and LISSADELL (WA) and the Fitzmaurice Group (in AUVERGNE, NT) are separated by about 30 km and there is no direct evidence that the two areas were ever part of the same depositional basin.

Since there is no consensus on the other group(s) with which the Fitzmaurice Group may correlate and since it appears that the group may have been deposited in its own basin, the new name, Fitzmaurice Basin, is used formally herein. The constituent formations in the Fitzmaurice Basin are described below.

## PALAEO–?MESOPROTEROZOIC

### *Fitzmaurice Group*

In ascending stratigraphic order, the four formations that comprise the Fitzmaurice Group are the Moyle River Formation, Goobaieri Formation, Lalngang Sandstone and Legune Formation.

The *Moyle River Formation* disconformably overlies the basement Bow River Granite (1853 ± 3Ma) in AUVERGNE and the Koolendong Granite and Murra-Kamangee Granodiorite (1852 ± 33 Ma) in PORT KEATS. It also unconformably overlies the Hermit Creek Metamorphics and Henschke Breccia. It is intruded by the Murrenja Dolerite. The latter is believed to have been intersected in petroleum well Moyle-1, where it gave K/Ar ages of 1393 Ma and 1537 Ma. Thus, the Fitzmaurice Group must predate these. The Moyle River Formation generally consists of fine- to coarse-grained quartz sandstone, and minor siltstone and pebble to cobble conglomerate (**Figure 20.4**, **20.5**). Up to 5% sericitised feldspar is present in the sandstone, which probably reflects derivation from the immediately underlying granite. A well developed intraformational conglomerate has been mapped in ANSON (Fahey and Edgoose 1986). In MOYLE, the Moyle River Formation contains some small lenses of volcanic rocks, dolostone and conglomerate (Edgoose *et al* 1989). The volcanic rocks were described as highly contaminated and altered finely crystalline rocks, which are commonly silicified and contain scattered phenocrysts of altered potassium feldspar in a turbid mass of chlorite, and chalcedonic and cherty quartz. Most of the phenocrysts have been altered to granular epidote, cherty quartz, clay minerals and feldspar, and may represent pyroclastics within an extrusive lava. The volcanic rocks have not been dated. A few scattered outcrops of dolostone contain conical and branching stromatolites. These are the only examples known from the basin. Elsewhere in the sandstones, ripples, mudcracks and flute casts (**Figure 20.6**) are the only diagnostic sedimentary structures. It is not possible to determine an accurate thickness for the Moyle River Formation; Dunster *et al* (2000) and Sweet *et al* (1974) each estimated about 1000 m in central AUVERGNE. The unit thickens northwest into PORT KEATS, where it contains several interbeds of siltstone reported to be up to 460 m thick (Morgan 1972). Morgan gave a total thickness of up to 11 000 m (his table 1). Further northwest, Mendrum (1972) gave a thickness of 10 400 m in the vicinity of Tom Turners Fault and indicated that the basal conglomerate was sourced from the northwest. It was thought that these thicknesses might have included other formations above the Moyle River Formation that were not recognised in first edition mapping. Second edition mapping by Dundas *et al* (1987) obtained a revised estimate of about 5000 m in southeastern CAPE SCOTT. This thickness excluded the possibility that other

[1] Names of 1:250 000 and 1:100 000 mapsheets are shown in large and small capital letters respectively, eg CAMBRIDGE GULF, ANSON.

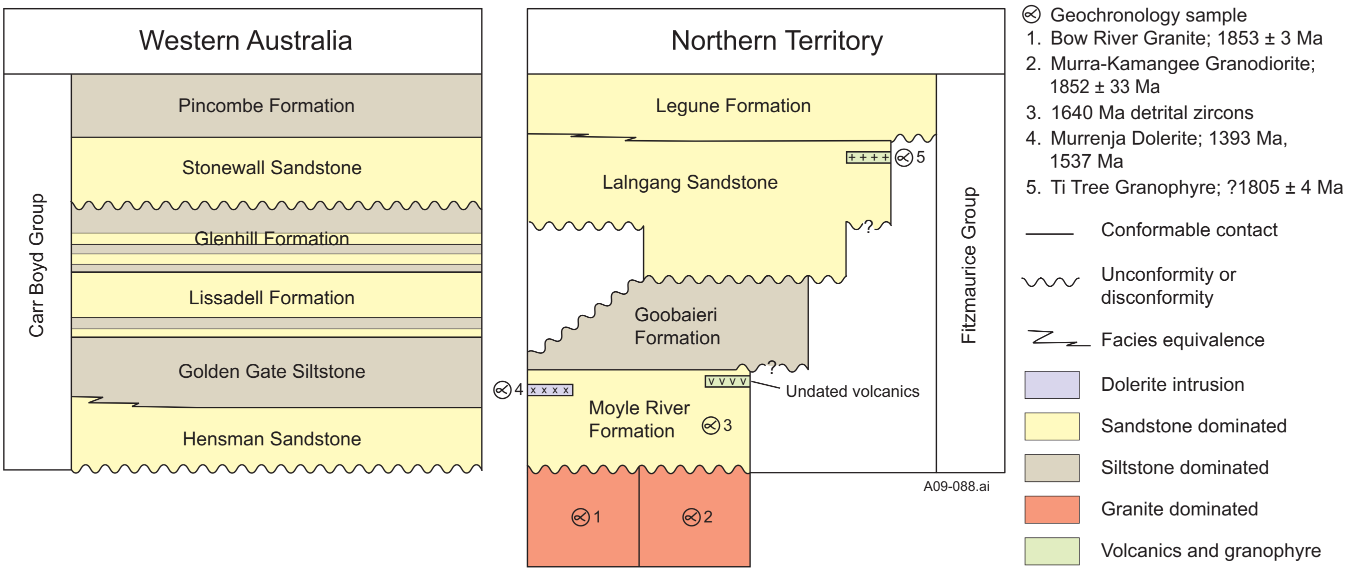


**Figure 20.3** Lithostratigraphic succession of the Fitzmaurice Group and a possible correlation with the Carr Boyd Group in western Australia, partly after Thorne *et al* (1999). This is only one of several possible correlations discussed here.

formations were present and structural repeats are unlikely. It is possible that the northern Moyle River Formation is laterally equivalent to other formations in the south. Even so, it is an enormous volume of sandstone to have been deposited and almost certainly indicates some concurrent tectonic activity.

The *Goobaieri Formation* conformably overlies the Moyle River Formation and comprises fissile siltstone, shale and medium- to fine-grained sandstone. The formation probably shows more lateral facies variation than the other members of this group, but a prominent, medial medium-grained sandstone forms a marker bed over much of its distribution. Cross-beds and ripple marks are present locally. There is no accurate thickness measured for the formation; Sweet *et al* (1974) cited in excess of 600 m as being typical. Hancock (1985) noted that Goobaieri Formation thickens from virtually nothing to 500 m over a distance of 25 km near Victoria River.

The *Lalngang Sandstone* is exposed over a large area from AUVERGNE northeast into PORT KEATS. In AUVERGNE, it is apparently conformable on the Goobaieri Formation, but it may be disconformable at a regional scale. In MOYLE, the Lalngang Sandstone is intruded by the Ti Tree Granophyre, which has given a possible crystallisation age of 1805 ± 4 Ma, but this is regarded as unreliable as it was based on too few zircons (Edgoose *et al* 1989). The Lalngang Sandstone typically consists of silica-cemented quartz sandstone, conglomerate, and minor siltstone. The sandstone is commonly thickly bedded with locally abundant cross-beds and ripple marks. In northwestern AUVERGNE, near Indian Hill, the Lalngang Sandstone contains more siltstone than elsewhere and little or no conglomerate. This is part of an overall trend towards more argillaceous lithologies in the northwest. The formation is 1400 m thick at the type section, but it may be considerably thinner elsewhere.

The *Legune Formation* has a generally similar outcrop distribution to the Lalngang Sandstone, covering almost the entire length of the basin in the Northern Territory. The two formations have a conformable, commonly gradational contact in AUVERGNE. On a regional scale, the Legune Formation may onlap the three other formations in the group (Sweet 1977) since it also apparently unconformably overlies the Whitewater Volcanics. In both the north and south extremes of its distribution in AUVERGNE, the Legune Formation generally consists of monotonous medium-grained silica-cemented quartz sandstone/quartzite (**Figure 20.7**) up

**Figure 20.4**. Cobble conglomerate that has eroded into underlying cross-bedded sandstone; cobbles consist of vein quartz, Moyle River Formation (CAPE SCOTT, ANSON, precise location unknown).

**Figure 20.5**. Moderately dipping Moyle River Formation (PORT KEATS, KEATS, Chalanyi Creek area, precise location unknown).

**Figure 20.6**. Flute casts in Moyle River Formation (CAPE SCOTT, ANSON, precise location unknown).

to 600 m thick. Some individual beds can be traced for up to 20 km, but elsewhere it is difficult to trace sandstone beds laterally due to subtle facies and compositional variations. The sandstone typically consists of >95% detrital quartz and the matrix/cement has been replaced by quartz, meaning that it is technically an orthoquartzite. The formation generally coarsens and includes more labile minerals to the southwest. In the central part of the outcrop area, around Legune homestead, the formation is exposed as siltstone with only minor fine-grained sandstone. Localised ferruginous phases associated with groundwater movement were described from north of River Peak (Byrne 1994). Mudcracks, ripple marks, current lineations and small-scale cross-beds indicate deposition in a high-energy, shallow-marine environment subjected to occasional influxes of coarser material. The only formations overlying the Legune Formation are Palaeozoic in age and the upper contact is clearly unconformable.

The overall environment of deposition for the Fitzmaurice Group might be analogous to that of the similar Carr Boyd Group in Western Australia. Rocks of the Carr Boyd Group have been interpreted as alluvial-fan, fluvial and shallow-marine shelf deposits which were laid down in an active strike-slip setting (Plumb *et al* 1985). However, Thorne and Tyler (1996) interpreted them as a braided delta complex, which prograded northward and northeastward over a low gradient, wave-influenced shallow-marine shelf. The fine grain size and compositional maturity of the sediment was taken as evidence that the source area probably lay several hundred kilometres to the south and southwest. Sediment was transported to the shelf by a system of shallow braided channels and redistributed at the delta front by waves and longshore currents.

**Figure 20.7**. Thin, parallel-bedded haematitic quartzite, Legune Formation (AUVERGNE, Keep, precise location unknown).

**Figure 20.8**. Development of a structural fabric in a sandstone/quartzite, Moyle River Formation (CAPE SCOTT, Anson, precise location unknown).

## STRUCTURE

The Fitzmaurice Group is only exposed in a northeast-trending structural corridor called the Fitzmaurice Mobile Zone (**Figure 20.2**). It is debatable if this represents the fundamental depositional basin or is merely its preserved remnants. Transcurrent faulting may have even moved the entire basin. Although many workers have postulated that deposition of the Fitzmaurice Group occurred during a period of rapid subsidence related to active transpressional or rift-bounding faults or foredeep development, there is, as yet, no documented evidence of growth faulting. The timing of basin formation and deformation is poorly constrained and it is probable that at least some structure is inherited from basement by the reactivation of older northeast-trending faults. In the far north of its distribution, the Moyle River Formation has developed a weak to moderate foliation adjacent to faults (**Figure 20.8**). Where deformation is more severe, crenulation and kinking (**Figure 20.9**) can be observed in finer-grained lithologies. In the south, the latest movements on the Cockatoo Fault System have offset the Fitzmaurice Group by hundreds of metres, but there is no discernable fabric in the rocks. The Victoria River Fault Zone (**Figure 20.2**) controls the present distribution of the group to the southeast, and the relationship with the Victoria and Birrindudu basins across the fault remains problematic. Further northeast, the group is only exposed to the northwest of Tom Turners Fault, which also trends northeast. This fault has an interpreted dextral sense and a vertical downthrow of at least 1000 m (Dundas *et al* 1987). The other major faults to affect the Fitzmaurice succession are the northeast trending Chalanyi Fault in PORT KEATS and the Whirlpool Reach and Indian Head faults in AUVERGNE. Apparent vertical displacements

**Figure 20.9**. Kink bands in micaceous sandstone, Moyle River Formation (CAPE SCOTT, Anson, precise location unknown).

along the Whirlpool Reach Fault range from >600 m to 1200 m. However, large-scale slickenlines and quartz fibres in a major shear zone to the south of Endeavour Hill indicate a significant strike-slip component was associated with its most recent movement. Thorne and Tyler (1996) interpreted that most of the post-Palaeoproterozoic sinistral faulting in the Halls Creek Orogen occurred after deposition of the Carr Boyd Group. The Indian Head Fault has an apparent vertical displacement of at least 1100 m (Sweet *et al* 1974) and may also have a significant strike-slip component.

## MINERAL RESOURCES

The Fitzmaurice Group has been included in regional stream-sediment sampling for diamonds and base metals (eg Perring and Turley 1982), but the sample coverage of most individual surveys was probably inadequate for base metals. In the mid-1980s, Western Mining Corporation Ltd explored for stratiform sediment-hosted base metals to the west of the Koolendong Valley. The Goobaieri and Legune formations were initially seen as being the most prospective in the Fitzmaurice Group (Hancock 1985). However, the area was downgraded after a brief reconnaissance, because of an apparent lack of syndepositional faulting which was an important part of their model. A BHP Minerals Pty Ltd–Carnegie Minerals NL joint venture investigated the potential for sediment-hosted copper mineralisation in the Fitzmaurice Group along the Victoria River Fault Zone (Stephens 1997) and undertook semi-detailed stream sediment sampling. During the late 1990s, the Legune Formation was targeted for base metal exploration (Pease 1998), but the limited work focused only on localised ferruginous phases. There has also been some conceptual targeting of unconformity-style uranium eg by Top End Uranium Ltd and Truscott Mining Corporation Ltd (Top End Uranium 2007, Truscott 2009). Top End Uranium also considered vein-style uranium mineralisation and Truscott also considered the area to be prospective for rare earth element mineralisation. The only report of precious metals is Brown (1895) who quoted assays from quartz veins in sedimentary rocks (presumably Fitzmaurice Group) near the mouth of the Fitzmaurice River in PORT KEATS. One sample showed 56.6 g/t silver and another showed traces (1.5 g/t) of gold. These reports have never been corroborated despite efforts by several exploration companies (eg Goulevitch 1992).

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