DRAINAGE EVOLUTION AND IMPLICATIONS FOR NEOTECTONICS AND MINERAL EXPLORATION IN THE COBAR UPLANDS, NSW

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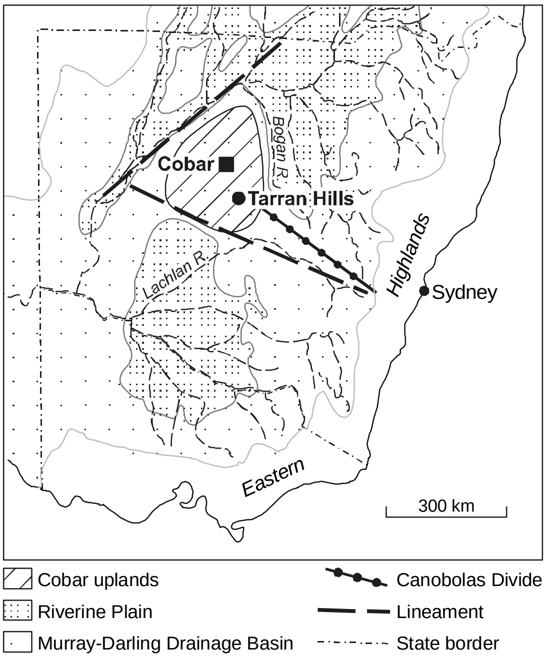
The Cobar uplands, in the northwest of the Lachlan Fold Belt, lie at the northwestern end of the Canobolas Divide, which is a major drainage divide between the Murray (south) and Darling (north) River catchments of central NSW (Figure 1). The Cobar region is framed by the Darling River, which arcs around the Cobar upland from the north to the west, the Bogan River, a major north flowing tributary to the Darling River which bounds the region to the east, and the west flowing Lachlan River to the south. The streams that drain radially from the Tarran Hills in the Erimeran Granite south of Nymagee, the highest area in the Cobar uplands region, become tributaries to one of these main drainage systems. Major faults and bedrock strike define the north-northwest trending physiography of the Cobar region (Figure 2) forming ridges which flank the granite intrusion in the highest part of the region.



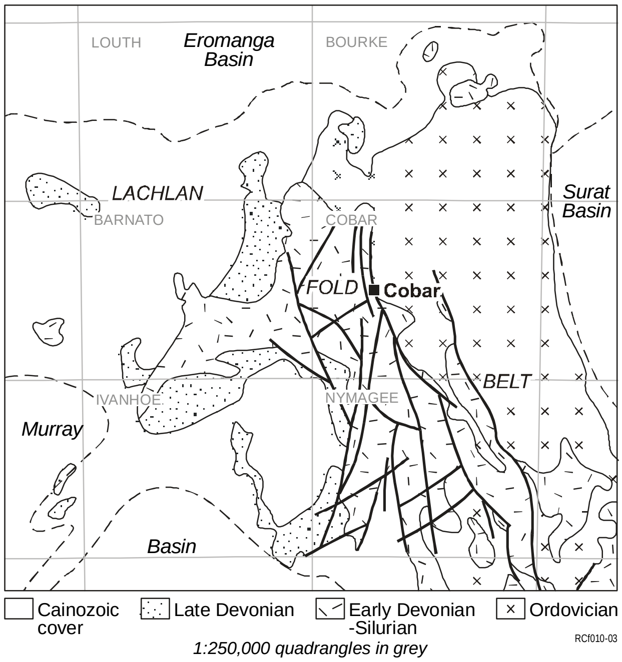


Figure 1 (left): Physiographic setting of the Cobar uplands, modified from Figure 1 of Butler & Hubble 1978.
Figure 2 (right): Geology of the Cobar region derived from Geoscience Australia web site and 1:2,500,000 scale Geological Map of New South Wales (1998).

The uplands are bounded to the northwest by the Darling River Lineament and to the southwest by the Lachlan River Lineament (Figure 1). Ordovician basement predominates in the eastern half of the area and comprises the Girilambone Group turbidite rocks, which have been regionally metamorphosed. The western half of the uplands is underlain by the Early Devonian Cobar Basin, comprising a marine turbidite succession that was deformed and structurally inverted in the Late Devonian to Carboniferous (Figure 2). Fluvial sediments were deposited on these older rocks in the Late Devonian. Deformation resulted in major folding and faulting with structures trending mostly between north-northwest and north-northeast. Diagonal secondary faults developed between these major structures.

The drainage in general follows the north-trending physiography, but in the western part of the Cobar upland the drainage follows the westerly trending diagonal faults and fractures between the major north-northwest to north-northeast trending faults. The mean elevation of the Ordovician to Early Devonian basement rocks is topographically higher than the mean elevation of Late Devonian and younger rocks, indicating that the region has experienced a minimum average differential uplift of 39 m (the difference between the mean surface elevation of Early and Late Devonian). This differential uplift is reflected in the drainage evolution of the region.

Drainage classification in the Cobar uplands, following Strahler (1952), has indicated an anomaly in the Sandy Creek catchment where a rapid increase in drainage order has occurred to the west of Cobar (Figure 3). The high density of faults and fractures associated with the Early Devonian Cobar Basin between Rookery Fault to the east and Jackermaroo Fault to the west (Figures 2, 4) is responsible for this increased drainage density and order. Mineralization in the Cobar uplands is largely structurally controlled, with most known deposits concentrated along the high strain Ordovician-Early Devonian eastern margin of the Cobar Basin (Figure 4). Other deposits are associated with faults within the basin and adjacent to the Early-Late Devonian western boundary of the Cobar Basin. To the east of Cobar deposits are associated with the Ordovician and possibly structurally in-faulted Siluro-Devonian and Early Devonian rocks.

Reconstruction of the drainage evolution of the Cobar uplands from inferred palaeotopography reflects neotectonic activity (Figure 5). The palaeotopography was reconstructed in stages by rebuilding previous relief and elevation, by taking into account the geology and morphology of eroded features and estimating denudation. The evolution of the drainage determined from this reconstruction can be modeled in relation to two major morphotectonic blocks aligned north-south, which converge to the north and fan outwards towards the south. This structure in reflected in the splay of faults in the Cobar Basin converging to the north (Figure 4). These two morphotectonic blocks moved around a pivotal point which lies on the north-south trending Thule Fault just north of its intersection with Dusty Creek Fault (Glen *et al.* 1996) (Figure 4) on the western edge of the Cobar Basin. Migration of drainage occurred to the south in the eastern block, and to the north in the western block. Migration of drainage in the eastern morphotectonic block is indicative of uplift from north to south while in the western morphotectonic block uplift has been from south to north. Drainage capture and reversal resulted from this tectonic reactivation. Drainage evulsion and redirection towards new base levels occurred as palaeotopography was buried around the margin of the Cobar uplands, due to ongoing erosion.

Ages have not been attributed to the stages of drainage evolution as palynological dating and detrital zircon provenance studies have so far been inconclusive. However, indicative correlations suggest a Late Jurassic to Plio-Pleistocene age range for the six stages of drainage evolution. These correlations are mostly based on sedimentology (palaeoflow directions), provenance of pebble lithology, and dated volcanic events (see Figure 5).

Stage 1

The palaeo-Kerrigundi system drains to the north-northwest, following basement structure, from high terrain in the southeast of the Cobar uplands. A remnant outcrop of conglomerates with rounded quartz-quartzite-lithic clasts interbedded with sandstone preserved beneath a silcrete cap on a rise at Belah Trig to the west of Cobar is interpreted as an alluvial fan with dominant imbrication to the north. Another remnant of conglomerates with a similar composition, but with matrix supported rounded and angular clasts, is preserved as a silicified east-west aligned and dipping mesa cap at Tyncin Trig to the northwest of Cobar, and is interpreted as a chaotic flow. These sediments appear similar to Late Jurassic sediments preserved sporadically on the Lachlan Fold Belt (Gibson & Chan 1999), and co-locate with the palaeo-Kerrigundi system.

Stage 2

The southwestern tributary arm of the palaeo-Kerrigundi system unifies and captures the headwaters of the southeastern tributary arm through accelerated headward erosion, perhaps induced by tectonic reactivation along associated fault segments.

Stage 3

Palaeo“A” creek flows to the south-southwest from Late Devonian bedrock headwaters into a fluvio-lacustrine embayment. Drainage diversion by capture of palaeo“C” creek, which previously flowed to the north, towards the west by palaeo“B” creek due to tilting of the eastern Cobar morphotectonic block to south, and exiting into the southwestern embayment. Fluvial foresets and clast imbrication is to the south for dated Cretaceous (Ludbrook, in Rayner 1969) sediments unconformably overlain by possible ice rafted boulders (Gibson & Chan 1999) at The Meadows gravel scrape to the west of Cobar. Tectonic reactivation of

Palaeozoic faults on the eastern side of the Cobar uplands may relate to cessation of convergence to the east in the Late Cretaceous and the resulting change in palaeoslope from north to north-west.

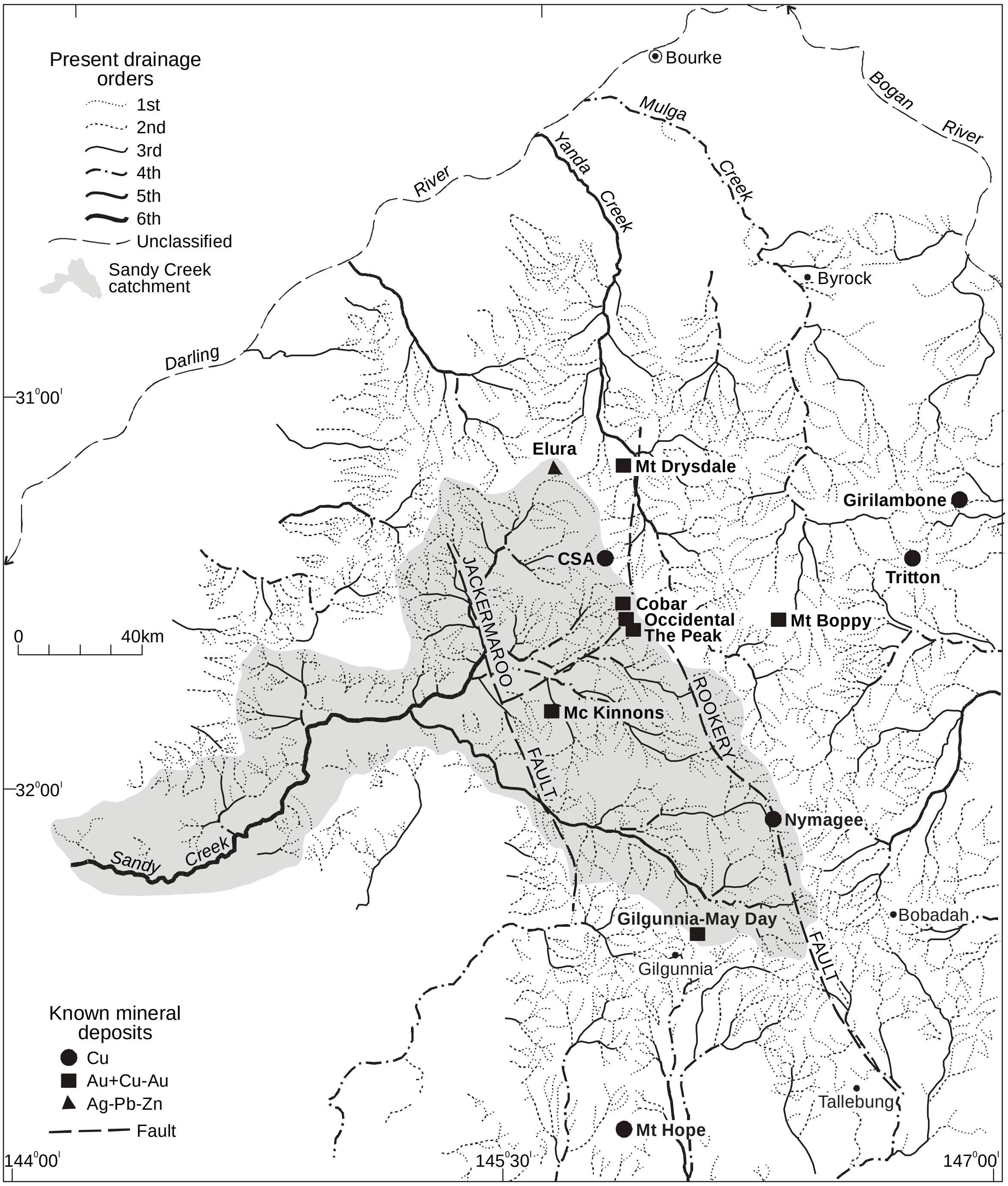


Figure 3: Present drainage orders and anomalous catchment with known mineral deposit locations in the Cobar uplands. Drainage base derived from Geoscience Australia NATMAP 1:250,000 scale topographic maps.

Stage 4

Palaeo"A" creek captures the west trending headwaters of palaeo"B" creek (via Sandy Creek) further towards the west due to tilting of the western morphotectonic Cobar block to north, and exits into the southwestern embayment. The beheaded palaeo"B" creek continues to flow south into the embayment. Tectonic reactivation of Palaeozoic faults on the western side of the Cobar uplands may relate to formation of the Murray Basin in the Palaeocene.

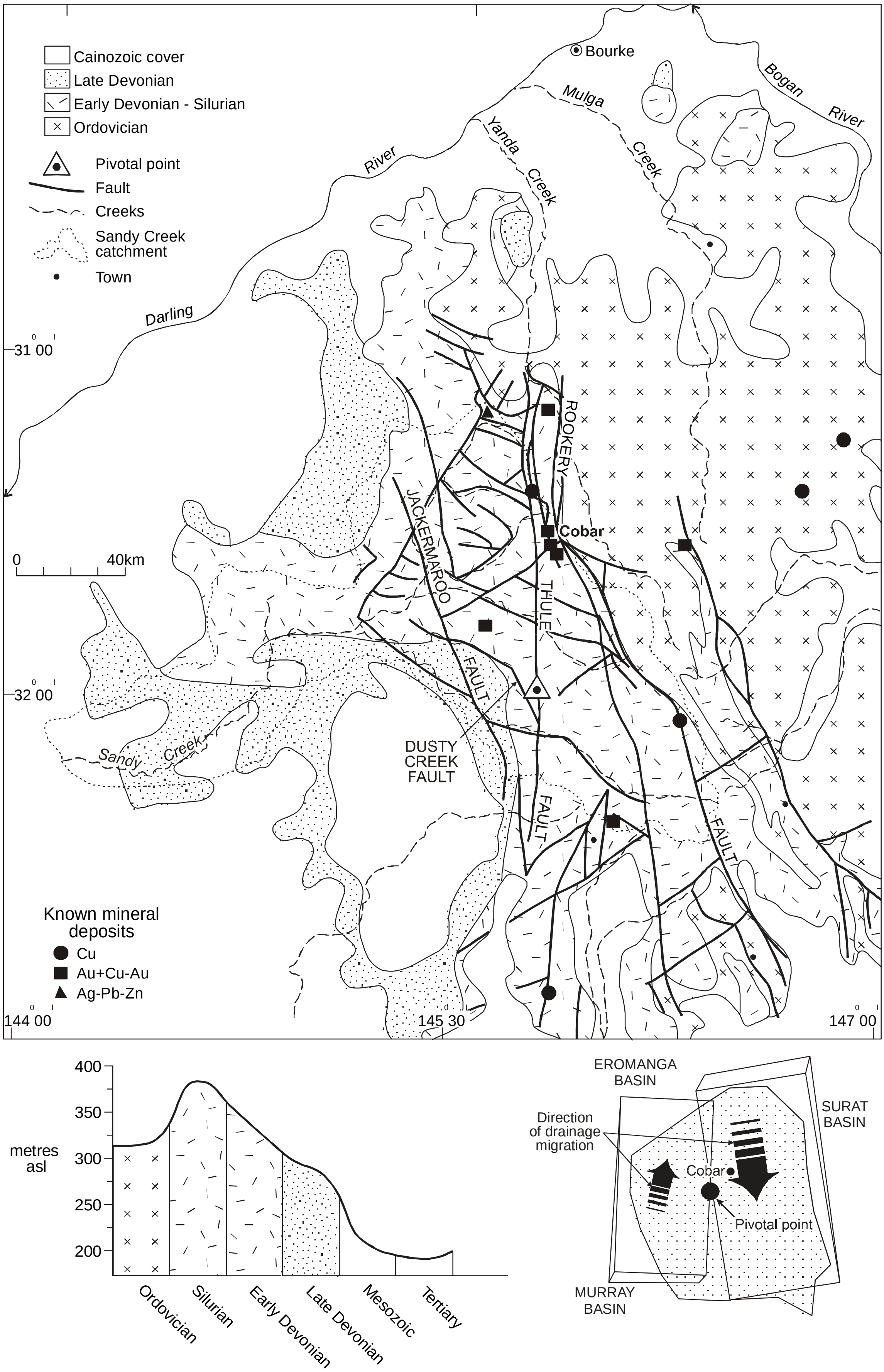


Figure 4: Geology and morphotectonics with known mineral deposits in the Cobar uplands. Faults derived from Glen *et al.* (1996) and 1:2,500,000 scale Geological Map of New South Wales (1998).

Stage 5

Sandy Creek captures the expanded west trending headwaters of palaeo”A” creek due to headward erosion from a low base level in the Murray Basin and flows west. The beheaded trunk streams of palaeo”A” and palaeo”B” creeks continue to flow south into the embayment. Early to mid Miocene volcanism, such as that burying sediments and saprolite at Wilga Tank to the east of Cobar, suggests a period of renewed tectonism, perhaps due to mantle hot spot activity, that may have increased the east-west stream gradient between the Cobar uplands and the Murray Basin at this stage.

Stage 6

Sandy Creek is beheaded of its northwestern tributary arm as it reverses its flow direction to flow towards the north due to continued tilting of the western Cobar morphotectonic block, and is captured by Windara Creek exiting to the west through a gap in the north trending Devonian ridge near Plain Paddock Tank to the west of Cobar. Buried fluvial palaeosediments are preserved at Plain Paddock Tank. With further tilting towards the north this beheaded creek is captured by Tambua Creek and exits to the west at Mount Gap to the northwest of Cobar. Palaeosediments exposed at Mount Gap are interpreted as dammed fluvio-lacustrine sediments prior to capture to the west, and may correlate with regional Plio-Pleistocene sedimentation in inland draining palaeorivers in central NSW.

The drainage has evolved in an anticlockwise direction in response to the formation of the Eromanga and Murray Basins (Figure 2) and their associated changes in base level. Northerly flowing drainage in the Mesozoic has changed to westerly flowing drainage in the Cainozoic. Palaeozoic faults have been reactivated due to the formation of the surrounding basins, and have significantly impacted on the drainage evolution of the region. Geomorphic evidence indicates that reactivation of this Palaeozoic structural framework continued into the Cainozoic. Apart from some small remnants, such as silcreted inverted relief ?Late Jurassic sediments and fluvial Cretaceous sediments, there is very little record of any Carboniferous to Cretaceous sedimentation, suggesting major erosional stripping or non-deposition. The present day drainage has evolved from a high-density drainage associated with wet climatic conditions, to a drainage characterized by sporadic or intermittent runoff, consistent with drier conditions.

Understanding the drainage evolution of the Cobar uplands has important economic implications. Geochemical exploration for polymetallic deposits in this region is hampered by shallow to thick cover of both *in situ* and transported regolith, particularly in palaeochannels. Knowledge of the palaeochannel systems can assist in the interpretation of transported or displaced geochemical anomalies. In the Cobar uplands there is potential for placer deposits of gold and platinum group elements in some of the palaeodrainage systems. Morphometric analysis of each stage of drainage evolution has the potential to highlight anomalous drainage order zones in catchments with fast growth of drainage orders, such as the Sandy Creek catchment in Stage 6. Low order drainage zones can reflect fractured areas, whereas placer deposits may be associated with higher order drainage zones. The potential for mineral exploration in the Sandy Creek catchment is high as there is an association of a denser fault network (Figure 4) with the north-northwest trending eastern headwater half of the Sandy Creek catchment. Many of the known mineral deposits (Figure 4) are associated with these faults, and drainage order and lineament analyses indicate the presence of additional, potentially mineralized structures. The analysis of drainage evolution is also a useful tool in the assessment of sediment transport directions over time, and the net foci of sediment deposition. Ongoing work will correlate data from drainage analysis with pertinent data from bedrock and regolith mapping, structural analysis and geochemistry to point to sites which are suitable for mineral exploration.

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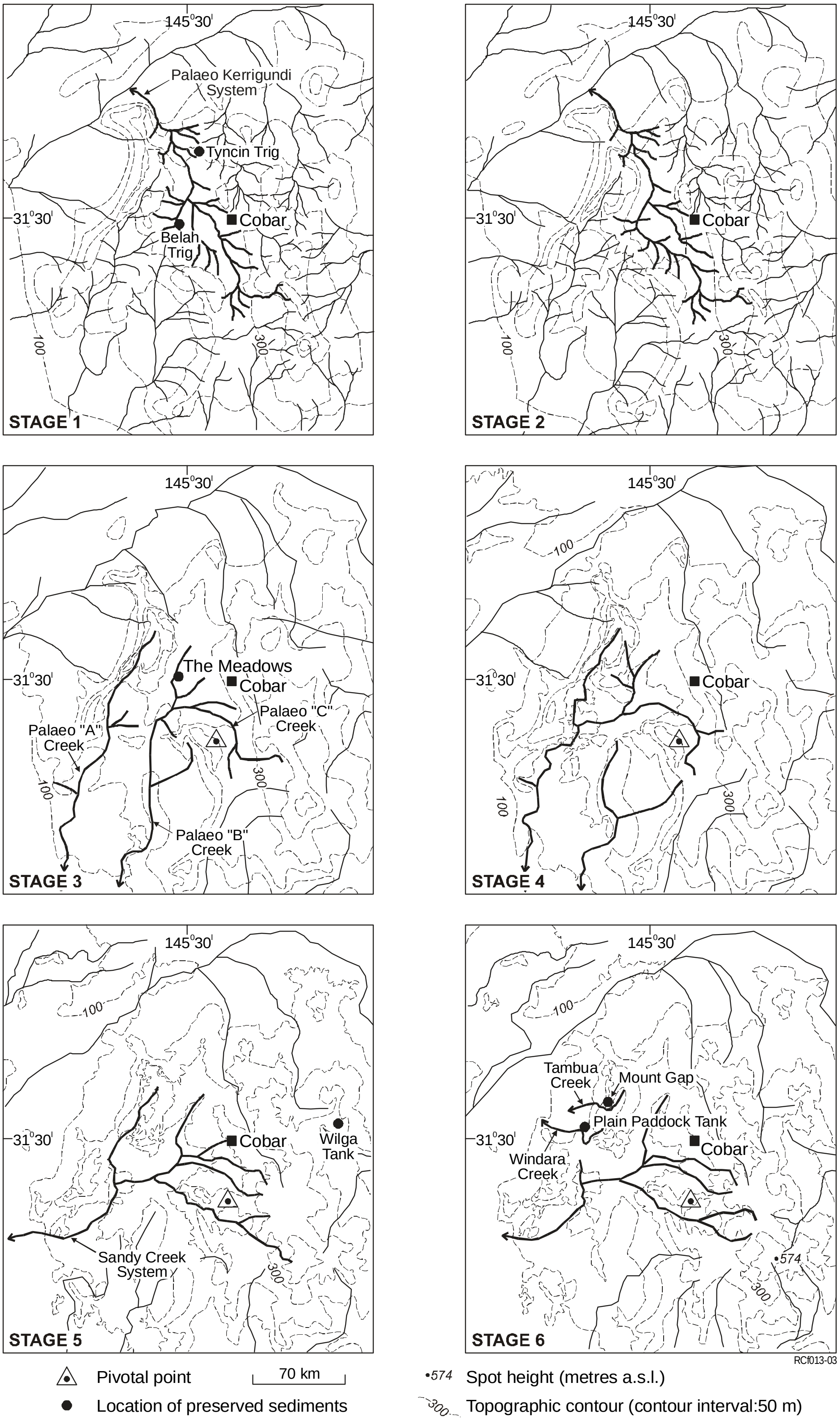

Figure 5: Drainage and topographic evolution stages for the Cobar uplands.

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