PALAEOGENE LAKES AND DRAINAGE EVOLUTION IN THE SHOALHAVEN AND UPPER WOLLONDILLY CATCHMENTS, SOUTHEAST NSW

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The upper Shoalhaven River in southeast NSW flows northward parallel to the coast for 110 km before turning abruptly east at the Tallong Bend near Tallong and flowing, as the lower Shoalhaven, into the sea. To the north, the Wollondilly River flows generally eastward before turning north near Canyonleigh about 10 km north of Tallong, eventually reaching the sea north of Sydney.

The country in much of the upper Shoalhaven and upper Wollondilly catchments is the undulating Shoalhaven Plateau of Craft (1928), mostly around 600 to 700 m above sea level with some hills, ridges and small high plateau remnants up to 900 m. The Shoalhaven and tributaries are deeply incised up to 500 m into the plateau downstream of a major knick point 35 km north of the Tallong Bend to form the Shoalhaven Gorge and tributary gorges. The Shoalhaven/Wollondilly divide is a subdued topographic feature in the Shoalhaven Plateau. Its lowest point near Tallong, the “Tallong Gap” of this paper, is at only 615 m. North of Canyonleigh, Craft referred to the plateau as the “Blue Plateau”. The altitude of this plateau increases to the north and west, and the north-flowing Wollondilly and tributaries have cut gorges into it, interpreted correctly by Craft and previously by Taylor (1911) as antecedent gorges.

PALAEOGENE BASALTS AND SEDIMENTS

Outcrops of Palaeogene basalts and non-marine sediments are widespread on the plateau surfaces, resting unconformably on early Palaeozoic to Triassic bedrock. Many of these occurrences are remnants of palaeovalley fills. The sediments are more widespread than shown on published 1:250,000 geological maps, particularly the Wollongong sheet. Not shown are Palaeogene sediments in the valley of the Wollondilly and its southern tributaries, and also in a palaeovalley crossing the Shoalhaven/Wollondilly divide at the Tallong Gap (Figure 1), where 40 m of these sediments have been proved by drilling. Many of the basalt outcrops have been dated by the K/Ar method (Wellman & McDougall 1974, Nott 1992). Some of the sediments have been dated by palynology.

Ages of the basalts and sediments in the area of Figure 1 are in two main groups. Basalts with early to mid Eocene radiometric ages of 42 to 50 ma are the most widespread. They overly and are interbedded with sediments, some of which have been dated by palynology as early to mid Eocene. Significantly younger basalts with mid Oligocene ages of 29 to 32 ma appear to be restricted to deep palaeovalley fills either side of the lower Shoalhaven not far downstream of the Tallong Bend. The Caoura Palaeovalley, over 100 m deep, on the north side trends approximately parallel to the lower Shoalhaven for 13 km. Sands, gravels, and clays are interbedded with and overlie the basalts on the south side, and also occur in the Caoura Palaeovalley mostly at and near the base of the basalt.

Nott (1992) concluded that there are also pre-Eocene sediments possibly as old as late Cretaceous in the Shoalhaven catchment, generally at altitudes of 600 m and above and usually silcreted or otherwise indurated. The evidence for sediments of this age is not supported by any direct methods of age determination and is otherwise not convincing. Outcrops shown as “pre-Eocene” in a map in Nott’s paper are demonstrably either early to middle Eocene or late Eocene to Oligocene. “Pre-Eocene” sediments east of Inverary Park at altitudes up to 645 m are interbedded with early-mid Eocene basalts and appear to be continuous with sediments in boreholes a few km to the west at altitudes around 600 m with palynofloras interpreted as mid-Eocene by Truswell & Owen (1988) or early Eocene by McPhail (2002). “Pre-Eocene” silcreted sands and gravels at about 600 m on the north side of the lower Shoalhaven occur on the sloping side of a small tributary of the Caoura Palaeovalley. Craft (1931) mapped many similar occurrences of silcreted sand and gravel on either side of the Caoura Palaeovalley, and they seem to have been originally sandy regolith formed by Palaeogene weathering of underlying Permian pebbly sandstone. The largest of these outcrops, near the east end of the Caoura Palaeovalley is shown on Figure 1, but the others are too small to show at this scale. “Pre-Eocene” sands and gravels on the south side of the lower Shoalhaven at 600 to 620 m are continuous with and at the same altitude as sediments overlying dated mid Oligocene basalt in

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the same area.

PALAEOGENE AND MODERN DRAINAGE

Nott (1992) interpreted the sediments on either side of the lower Shoalhaven gorge as old sediments of the lower Shoalhaven, and he concluded that the river was in its present position draining east in the earliest Cenozoic or earlier. This conclusion is based on false premises. The sediments are clearly related to the late Eocene to Oligocene palaeovalleys and not related at all to the present lower Shoalhaven. valley.

Nott *et al*. (1996) noted Oligocene basalt outcrops extending up to 70 m down the sides of the Shoalhaven Gorge and a tributary gorge, where palaeovalleys meet the gorges They interpreted these outcrops as having flowed over the sides of the gorges from shallow palaeovalleys less than 10 m deep, and remaining in place since the Oligocene. They took this as clear evidence that the Shoalhaven was in its present position in the Oligocene and nearly as wide (but much shallower) than at present This interpretation of the palaeovalleys is completely erroneous. The basalt outcrops on the sides of the gorges are *cross sections* of *deep* palaeovalley fills which have since been *truncated* by the gorges. Sections of 57 m of basalt and sediment occur in water bores, which did not reach bedrock, in the Caoura Palaeovalley; and sections of basalt and sediments over 80 m thick are exposed in steep-sided valleys cutting across it. The incorrect interpretation of the palaeovalleys led to a calculation of the Cenozoic rate of gorge widening which was too low by about two orders of magnitude, and an erroneous geomorphic history. These errors were repeated in a later paper by Young & Wray (1999). There remains no evidence that the Lower Shoalhaven was in its present position in this area before the mid Oligocene, and the present gorge is the result of later Neogene erosion.

I suggest that the late Eocene lower Shoalhaven flowed east through the Caoura Palaeovalley. The bed of the palaeovalley is at about 530 m and 490 m at its east and west ends respectively. I have mapped another significant palaeovalley at the southeast margin of the Wingello basalt outcrop. It is about 150 m deep, with a basalt fill. Its bed is at around 510 to 540 m, apparently decreasing in elevation to the east. It could well be the early Eocene channel of the lower Shoalhaven, or possibly a tributary channel.

PALAEOGENE LAKES

Nott (1992) correctly concluded that the Oligocene basalts formerly dammed easterly Shoalhaven drainage to form a narrow lake about 80 km long upstream of Tallong, now filled with about 100 m of lacustrine clay and silt and lacustrine deltaic sand and gravel. Organic-rich clays near the base of the fill were found to contain mid Oligocene palynofloras (Nott & Owen 1992). McPhail (2002) has since concluded that palynofloras of clays in the most downstream lake sediment outcrops and at the base of the Caoura Palaeovalley are most likely late Eocene or earliest Oligocene. This does not negate Nott’s explanation for the lake’s origin since the Oligocene basalt ages are from at and near the top of the basalt, and flows at the base of the palaeovalley fills could well be significantly older.

Nott placed the basalt dam in the present lower Shoalhaven valley, but I suggest instead that it blocked a former lower Shoalhaven course through the Caoura Palaeovalley, where much of the dam is still preserved. Nott perhaps implied, but did not specifically state, that the lake overflowed the basalt dam. However the altitude of the top of the basalt is 620 to 630 m, well above the bedrock elevation, 575 m, in the Tallong Gap. This observation and the distribution of late Eocene to Oligocene sediments (Figure 1) show that it more likely overflowed north through the Tallong Gap into another lake in the Wollondilly valley.

There are also early to mid Eocene lacustrine sediments in the area. Nott (1992) recognised lacustrine sediments including laminated clays and silts in early to mid Eocene sediments associated with basalts in two areas of the upper Shoalhaven catchment at Titringo Creek, (an Endrick River tributary, near Nerriga) and in the Inverary Park area near Bungonia. Well sorted sands and fine gravels in the latter area may be lake shoreline sediments. Nott interpreted these two occurrences as deposits of two individual lakes formed by damming of drainage by lava flows in their immediate areas. This explanation is not satisfactory for the Inverary Park area because the sediments occur mainly downstream of the basalt.

Sediments at least in part lacustrine, including well sorted sands and gravels and laminated silts with leaf fossils occur interbedded with and underlying 50 ma (early Eocene) basalts south of Wingello and north of the lower Shoalhaven and Caoura Palaeovalley. Another significant occurrence, not previously recognised, is an outlier of about 30 m of sands, silts, clays, and fine gravels at Stoney Range Hill 20 km west of Wingello in the Wollondilly catchment. The sediments are overlain by a 60 m thick ankaramite flow (mafic rock with abundant large pyroxene crystals).

Altitudes of the top of the sediments at these various localities increases to the north and west from about 530m at Titringo Creek to 645 m near Inverary Park, 680 m near Wingello, and 700 m at Stoney Range Hill. At the latter three localities they are well above the Shoalhaven/Wollondilly divide. The sediments and ankaramite at the latter locality have not been dated. They are at a similar altitude to the early to mid Eocene occurrences near Wingello, and probably the same age. They are well above the nearest dated late Eocene to early Oligocene sediments at about 600m in a borehole near Tallong (McPhail 2002). Two Cenozoic sediment outcrops shown on the Wollongong 1:250,000 sheet 10 km north east and north northeast of Wingello at about 720 and 730 m may also be the same age.

I suggest that all of these occurrences could well represent erosional remnants of a single early to mid Eocene lake which formerly covered much of the present upper Shoalhaven catchment and extended across the present divide into the present upper Wollondilly valley. The differences in elevation are interpreted as due to gentle relative southerly tilting. There are two main possibilities for a dam to form such a lake; either upwarp of the Blue Plateau north of Canyonleigh, or damming by basalts in the lower Shoalhaven valley, including those near Wingello.

CONCLUSIONS

A possible history of Cenozoic drainage and lake evolution consistent with field observations is as follows:

a) Ancestral pre-Eocene northerly drainage, with the upper Shoalhaven joining the lower Wollondilly;
b) Pre-Eocene or early Eocene diversion of upper Shoalhaven and upper Wollondilly drainage to the east due to upwarp of the Blue Plateau to the north and some downwarp toward the coast;
c) Blocking of easterly drainage starting about 50 ma by basalts of the Wingello area (formerly more extensive) to form a large lake which drained north along the ancestral drainage line;
d) Gradual filling of the lake with sediments, with continuing eruption of lavas which eventually largely or completely covered the sediments by the mid Eocene. Mid to late Eocene erosion of the northern overflow leads to some erosion of the basalts and sediments;
e) Gentle southerly tilting of the Shoalhaven Plateau and further southeasterly downwarp toward the coast. Upper Shoalhaven and upper Wollondilly drainage are diverted east around the southern margin of the Wingello basalts in the late Eocene and erode the Caoura Palaeovalley. Extensive erosion of older Eocene lake sediments and basalts exhumes some early Eocene valleys;
f) Eruption of late Eocene to mid Oligocene basalts from centres to the east, backing up the Caoura Palaeovalley and tributaries and blocking easterly drainage to form a lake in the upper Shoalhaven and Wollondilly valleys. The lake drained north along the ancestral drainage line and slowly filled with sediment;
g) Relative downwarp to southeast toward the coast in the late Oligocene or later. Rejuvenation of easterly drainage causes re-capture the upper Shoalhaven. Wollondilly drainage continues to the north. Major gorge cutting by the Shoalhaven and tributaries continues to the present.

As a possible alternative to events (b) and (c), the basalt could first have diverted easterly Shoalhaven drainage into a north-draining Wollondilly, which was subsequently dammed by upwarp of the Blue Plateau to form a lake which drained north.

Woolnough & Taylor (1906) concluded that the upper Shoalhaven formerly continued north across the present divide to join the north-flowing Wollondilly, and proposed that it was diverted east in the late Cenozoic. Ollier & Pain (1994) concluded that the lower Shoalhaven is a former tributary of a north-flowing drainage, reversed by Cenozoic or late Cretaceous downwarp of the coast. The idea of a former connection between the two rivers was argued strongly against by Craft (1931) and more recently in several papers by J. F. Nott, R. W. Young and co-authors. These latter authors maintain that the Shoalhaven has drained east and the drainage lines and divides have remained essentially unchanged since the earliest Cenozoic or earlier.

This view is inconsistent with the presence of early to mid Eocene sediments near the Shoalhaven/Wollondilly divide at altitudes well above the divide; and is also inconsistent with the presence of a palaeovalley with 40 m of probable late Eocene sediments crossing the lowest part of the divide near Tallong. While my alternative possible histories may well be modified in the light of later studies, I strongly believe that further work will confirm a Shoalhaven-Wollondilly connection having occurred at various times during the Cenozoic; with volcanism and gentle tectonic tilting or warping causing ponding and other major changes to drainage.

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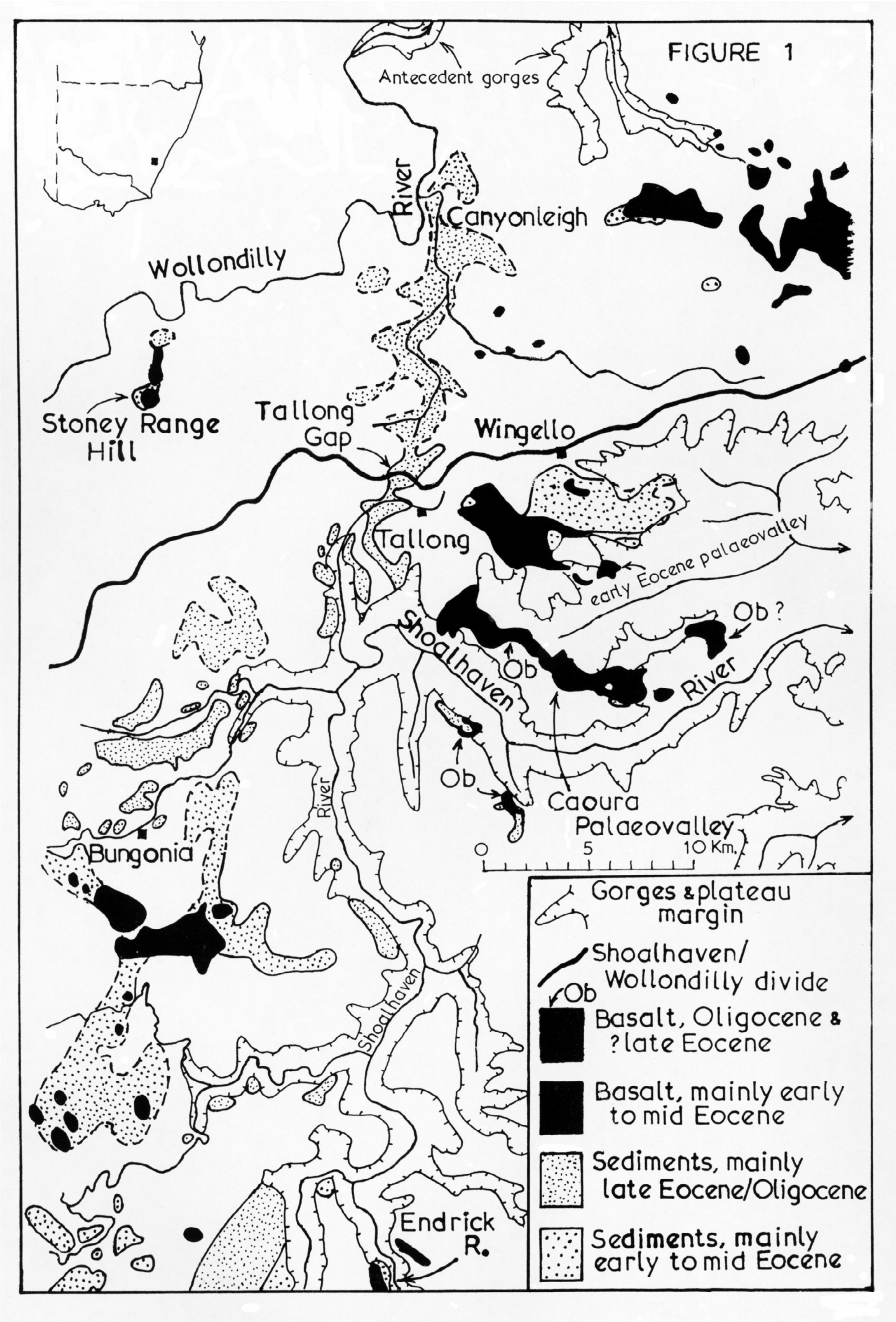

Figure 1: Map of parts of the Shoalhaven and Wollondilly catchments, showing main topographic features, areas of Palaeogene sediments, and localities. Boundaries shown by broken lines are based on the author's reconnaissance mapping. Unbroken boundaries are based on the author's detailed mapping or publications including Craft (1931), Nott (1992), and 1:250,000 Geological sheets.