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Research paper

Australasian asphaltite strandings: Their origin reviewed in light of the effects of weathering and biodegradation on their biomarker and isotopic profiles

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ABSTRACT

Asphaltites, long known to strand along the coastline of southern Australia and as distantly as New Zealand and Macquarie Island, are widely regarded as artefacts of submarine oil seepage. Their remarkably uniform composition suggests a common source: marine shale containing sulphur-rich Type II kerogen, probably deposited during an Early Cretaceous oceanic anoxic event (OAE). Suitable hydrocarbon kitchens may exist in the offshore Bight and Otway basins. The physical character of the asphaltites, including laminations and flow structures, and their degree of alteration, which is not the result of biodegradation or extensive water washing, suggest an origin from subsurface tar mats subsequently exposed by the incision of submarine canyons, with the possible formation of asphaltic volcanoes. API gravities of 4–18° impart quasi-neutral buoyancy, implying many asphaltites were submerged drifters prior to stranding, their degree of weathering reflecting, at least in part, the residence time in the marine environment. For any individual asphaltite specimen, this will depend on the proximity of the seafloor seep to the stranding site, an important consideration when attempting to locate their point of origin.

This study investigates the hydrocarbon biomarker signatures and *n*-alkane $\delta^{13}C$ profiles of asphaltite specimens from stranding sites on the Eyre Peninsula ($n = 2$), Kangaroo Island ($n = 4$) and the Limestone Coast ($n = 3$), South Australia, and the south island of New Zealand ($n = 2$). Sub-samples of the interior and weathered surface of each specimen were analysed. No distinction could be made between strandings based on their source-dependent molecular and isotopic signatures, confirming their common origin. Comparison of the interior and exterior sub-samples revealed subtle although consistent differences. Given their degree of degradation and isotopic variance, these Australasian asphaltites seem to be products of low intensity seeps in the Ceduna Sub-basin of the Bight Basin and/or Morum Sub-basin of the Otway Basin.

1. Introduction

Reports of bitumen strandings on the coastlines of South Australia, Victoria, Tasmania and Western Australia date from the early 19th Century (Sprigg and Woolley, 1963; Currie et al., 1992; Volkman et al., 1992; McKirdy et al., 1994; Padley, 1995; Edwards et al., 1998 and references therein). The locations of these strandings along Australia's southern margin (Fig. 1), and their greater frequency in southeastern South Australia, western Victoria and southern Tasmania, fuelled early petroleum exploration in the region on the assumption that they were sourced from local submarine seepages (Sprigg, 1986; Volkman et al., 1992; McKirdy et al., 1994). Accounts describe a variety of oily substances that can be assigned to three categories, each with a different origin: oils (crude and refined), waxy bitumens and asphaltites (McKirdy et al., 1986a,b, 1994; Edwards et al., 1998). While the early reports were

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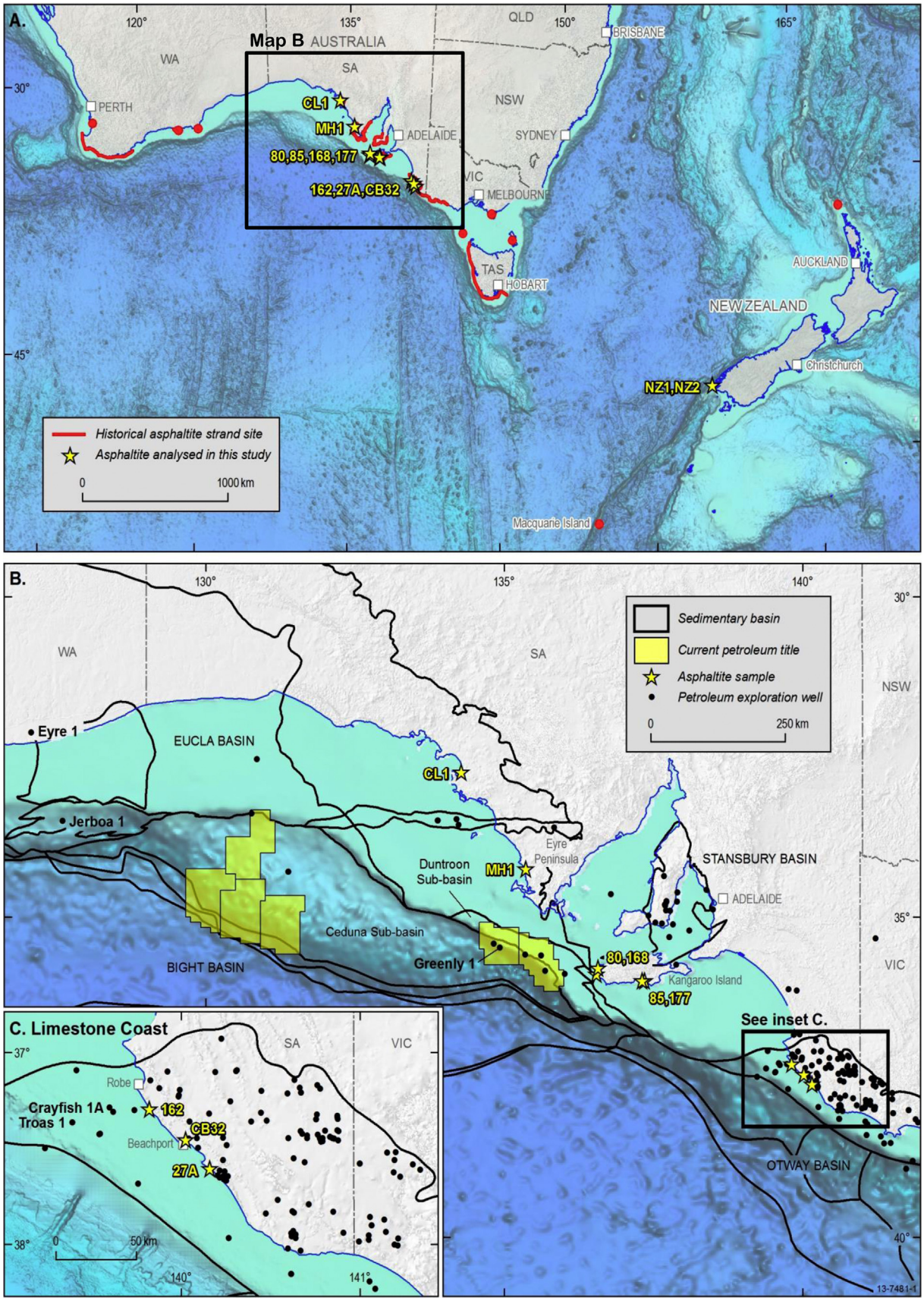

Figure 1. A) Location of historically documented asphaltite strandings and samples from this study; B) expanded section for South Australia with sample stranding sites, basin locations and petroleum exploration well sites; C) expanded section for the Limestone Coast, South Australia with sample stranding sites and petroleum exploration well sites.