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The Lonnavale oil seep

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Abstract

Natural liquid petroleum, probably derived from Permian *Tasmanites*-bearing strata, has been found in zeolite-calcite filled faults and joints in Jurassic dolerite near Lonnavale, in the upper Huon district. It was formed contemporaneously with the vein minerals and appears to be Jurassic in age.

Introduction

There have been many historical reports of oil and gas seeps throughout Tasmania. However prior to this discovery, none of these have been verified and it has been considered that few, if any, of these are genuine hydrocarbons generated by natural geological processes (Bacon *et al*., 2000). To date the only commercial onshore hydrocarbon production in Tasmania has been the result of small-scale retorting of Permian *Tasmanites*-bearing oil shales in the Mersey–Forth district.

There has recently been some renewed exploration interest and some possible source rocks (Ordovician carbonate sequences and the Permian Woody Island Formation), reservoirs (Permo–Triassic sandstone) and seals (Jurassic dolerite) have been conjectured (Bacon *et al*., 2000).

The Lonnavale area was visited briefly in 1995 and 1996, following reports by bushwalkers of an unidentified mineral occurrence. The location (~482 700 mE, 5 247 800 mN) is a small, recently used but unregistered quarry, presumably used by Forestry Tasmania to supply road metal to logging roads in the area. The quarry is located on Russell Road, about six kilometres northwest of Lonnavale (fig. 1).

Geology and petroleum occurrence

The quarry is located within a fine grained part of a Jurassic dolerite sill, close to an enclosed, small body of fossiliferous Permian mudstone (fig. 1). The mudstone is well exposed in a small, older quarry about 300 m to the southeast, and appears to lie immediately below a dolerite sill. The contact is obscure and probably faulted; the course of Lonna Creek, which strikes northeast on the northwestern side of the quarry, may be related to this fault.

A major NW-striking fault may bound the northwestern part of this Permian body, which is poorly known but probably comprises parts of the Abels Bay and/or Minnie Point Formations (S. M. Forsyth, pers. comm.). The hydrocarbon occurrence appears to be near the base of a dolerite sill, in a faulted zone close to the Permian contact.

The dolerite exhibits two generations of fractures and breccia veins, both probably related to the fault, striking about northeast and up to about 100 mm in width. The earliest are approximately vertical and are rarely vuggy, sometimes sheeted, with the host dolerite being largely altered to green-brown smectite (montmorillonite?) and other secondary minerals. These zones contain uncommon patches of blue-green calcite, probably stained by microscopic inclusions of fine-grained pumpellyite (?), as occurs in similar veins in dolerite at Lower Longley. The veins are zoned and are mostly lined with crystalline laumontite (crystals up to 5 mm in length), and are filled with calcite and minor globules and flecks of bitumen (sample C104496).

The later veins dip around 45° to the southwest and are hosted by less altered dolerite. They are commonly vuggy, containing coarsely crystalline calcite (crystals to about 100 mm across) overgrown with finer grained, partly crystallised pyrite, chabazite, stilbite and stellerite (a stilbite-like zeolite) (sample C104497). The bitumen is also common in these veins. Thin heulandite veins also occur; these may be an earlier generation and do not appear to contain bitumen.

Bitumen occurs in both vein sets, but is more common in the later vein set, and is abundant in some samples. It is dark brown to black, vitreous, soft and sticky when fresh, but hardens and darkens to dull black on exposure to air. It readily leaves oil stains on paper, indicating a moderate content of low to moderate molecular weight hydrocarbons. Only low viscosity, volatile, oily fluids were encountered on breaking some samples. The bitumen in the early veins occurs as globules and sheets that range from about 1 mm to about 40 mm in size, but are rarely more than 10 mm thick, and are commonly enclosed by calcite crystals (up to 10 mm in size).

In contrast to the earlier veins, much of the bitumen in the later veins is shattered, veined and overgrown by calcite, stilbite and possibly other zeolites. In some samples it shows a network of shrinkage cracks, filled with the latter minerals (fig. 2). These textures indicate contemporaneous formation of the bitumen and vein minerals and therefore demonstrate a natural origin for the former.

Samples of this bituminous material were chemically tested by AMDEL (Whythe and Watson, 1996) and CSIRO (Revill, 1996) and confirmed to be natural, probably with a Permian *Tasmanites* source (Bacon *et al*., 2000). *Tasmanites*-rich beds occur near the base of correlates of the Woody Island Formation in parts of northern, central and southern Tasmania (S. M. Forsyth, pers. comm.). Overall the Formation and its correlates are considered to be the prime, albeit lean, potential source rocks for hydrocarbon generation in the Lower Parmeener Supergroup (Bacon *et al*., 2000).

Discussion

Zeolitisation in Jurassic dolerites in Tasmania was considered by Sutherland (1977) to have been at least partly earlier than early Palaeocene faulting, and he interpreted one common assemblage, laumontite + prehnite, as forming at moderate temperatures and depths of burial (1600–2200 m). In contrast the assemblage chabazite + stilbite was taken as implying higher temperature and shallower burial (800–1600 m). Sutherland (1977) suggested that the former assemblage may be older (Jurassic), whilst the latter assemblage may be Late Cretaceous, although this is poorly constrained. The hydrocarbons at Lonnavale appear to be in both assemblages, although there is no indication of a Cretaceous heating event, and the age is tentatively ascribed as Jurassic.

Intrusion of Jurassic dolerite probably drove the temperature of the Permian strata through the 'oil window', and the volatilised hydrocarbons were circulated into largely sediment-derived, dolerite-heated, convecting hydrothermal fluids. These were trapped during cooling with precipitating carbonates and zeolites in faults and fractures in the overlying dolerite. The hydrocarbons were probably sourced within the Permian Woody Island Formation or correlates. These strata probably underlie the occurrence as there is no evidence for thrust faulting or moderately dipping permeable horizons along which the fluids could have travelled laterally.

References

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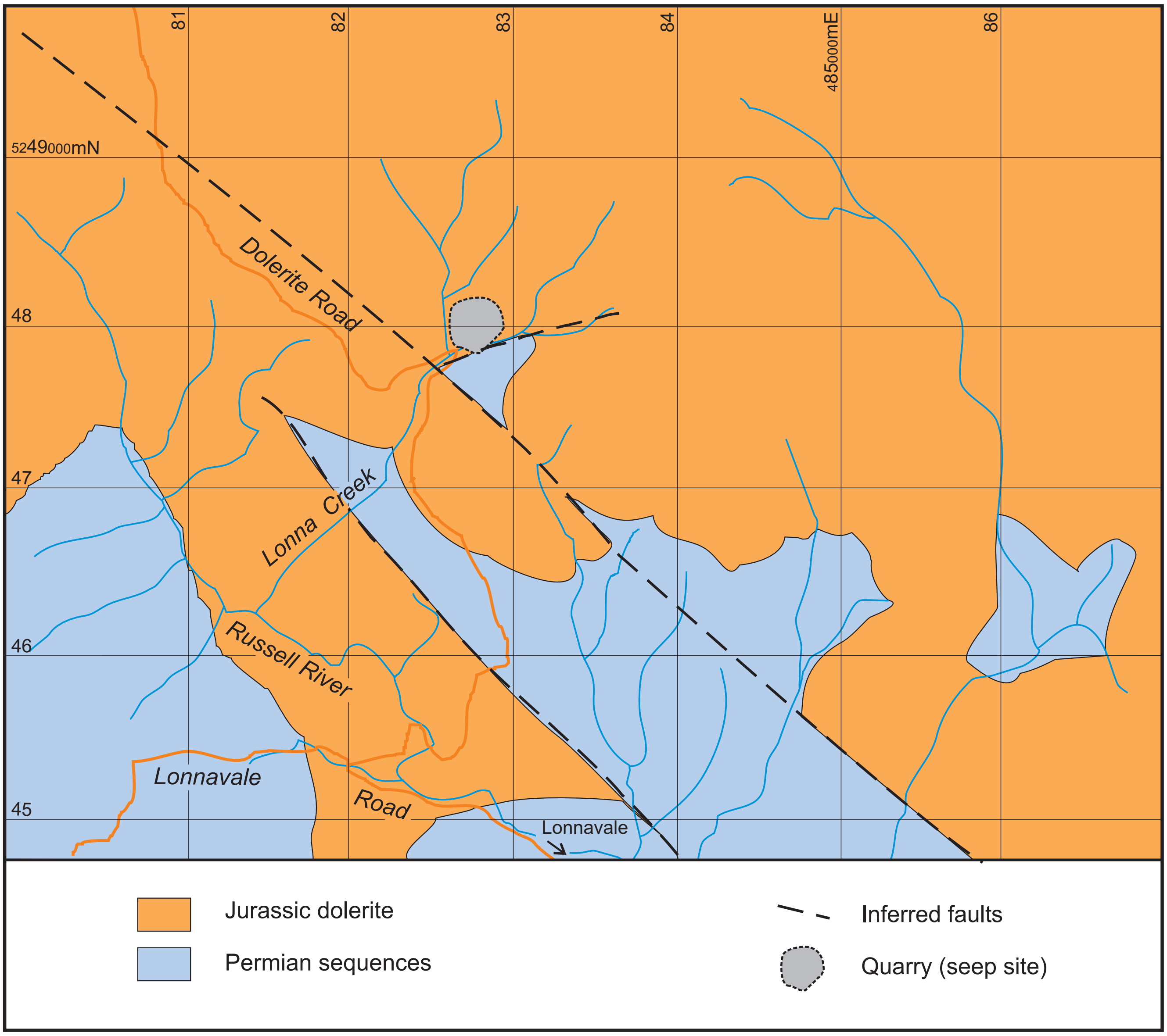

Figure 1

Geology of the Lonna Creek district, showing the quarry and location of oil seep. Geology is approximate and adapted from reconnaissance studies by S. M. Forsyth.

Figure 2

Photomicrograph of a bitumen sample from Lonnavale, showing shrinkage cracks filled with calcite and zeolites. Sample C104494. Field of view: 9 × 15 mm.