HAUNTED HILL GRAVELS: DEPOSITION AND NEOTECTONIC HISTORY ALONG THE SOUTHERN AUSTRALIAN COAST

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INTRODUCTION

Australia is surrounded by passive margins and is commonly viewed as the least tectonically active continent on Earth. However, given the current topography of the area, the southern margin may have been more active than widely believed over the last few million years. The Haunted Hill Gravels found throughout Southern Victoria consist of a diverse group of quartz gravels, which may record the neotectonic history of this area. The gravels found in the Toora Tin Fields, north of Toora, Australia (see Gardner, Figure 1, this volume, for location), contain cassiterite, which made them favorable for tin mining. The Australian Geological Survey did an initial study of the area in the 1950s, but it considered only the economic aspects and did not address the geologic history. This sequence of gravels (up to 30m thick) rests on Cretaceous bedrock, and Eocene basalt. It appears to have been deposited by fluvial action in post-Eocene times. Devonian granitic mountains to the south, on the northern side of Wilsons Promontory, also contain cassiterite, and represent a reasonable source for the gravel. Similar mineral compositions (quartz, cassiterite and tourmaline), and the distance (25km) between the two areas provide good evidence for this argument. The area of study is bounded to the north by the Yarram Fault and to the south by the Toora Fault, and is separated from Wilsons Promontory by Corner Inlet, which may have subsided after the deposition of the gravel. The high elevation of these gravels, up to 200 m, suggests recent uplift sometime after their deposition. Tilting and deformation of the gravels along the Yarram fault provide evidence that these faults were active after deposition. Taken together, the distribution and provenance of the Haunted Hill Gravel and its relationships to structural features reinforce the evidence of active tectonism along the southern Australian margin.

Methods

The study area encompasses four-abandoned tin mines in the Toora Tin Fields, and minor nearby sites. The lithology, sedimentology, and structure of the mines were constrained by field observation and measurement of stratigraphic sections, providing important evidence of depositional environments. In addition, grain size statistics of the sediment at each locality were determined by means of standard sieve techniques. Samples were collected for cosmogenic dating, which is still in progress.

Mineral separations using heavy liquids, bromoform (density 2.84 g/ml) and methylene iodide (3.31 g/ml), were also completed in order to separate the tourmaline from the heavier minerals. Finally, the heavy opaques were run through a Franz magnetic separator in order to pull cassiterite from the other heavy minerals by magnetic susceptibility.

In order to measure the thickness of the gravel, a GPS survey of the tin mines was completed. These measurements were compared those recorded in the 1955 study. This thickness is important to determine the amount of

sediment deposited, as well as its use in cosmogenic dating.

LITHOLOGY

The Haunted Hill Gravel is primarily composed of quartz, but also contains clay, feldspar, granitic fragments, tourmaline, cassiterite, and other heavy minerals. The quartz is primarily clear granitic quartz, which is sub-angular to sub-rounded and ranges in size from fine sand to cobbles. The cobbles tend to be better rounded and are found sparsely throughout the sediment. The largest cobbles are approximately 6 cm by 4 cm. Large clay rip-up clasts as well as thick clay beds are also found at some of the sites. Although the sediment is clast-supported, a matrix of clay is found throughout the area.

The heavy minerals are primarily tourmaline and some cassiterite. Both of these minerals are important in determining a source area. Cassiterite was once mined from the area and its presence is also significant for economic geology. Tourmaline is much more abundant than the cassiterite and ranges in size from fine sand to almost granule size. Because it is denser than clay and quartz, it settles out earlier and marks bedding and cross-bedding surfaces. It also provides useful marker horizons for recognizing fault offsets.

The granite found at Wilsons Promontory is an S-type granitic intrusion, and its average modal composition is 30-38% K-feldspar, 17-25% plagioclase, and 5-12% biotite (Hill & Joyce, 1995). The granite also includes a number of secondary minerals, the most abundant being tourmaline, cassiterite, and garnet (Wallis, 1988).

SEDIMENTOLOGY

The sedimentology of the area is important in connecting the Haunted Hill Gravel to its source area. Many of the sites contained cross-bedding and pebble imbrication. These were measured in section and plotted on a rose diagram to determine paleocurrent direction (Figure 1). This plot indicates that flow was to the north-northeast, which links the sediment to Wilsons Promontory to the south (Figure 1, Gardner, this volume).

Grain size analysis on two samples from two different sites showed the grain size ranged from cobbles (<256 mm) to coarse silt (<$^1/_{16}$ mm). The mean grain size was very coarse sand ($^1/_2$ mm – 1mm). The standard deviation of the samples was 1.22ϕ, which implies that the sample was poorly sorted. However, this is still within the range of fluvial deposition.

Stratigraphic sections show individual sections that tend to fine upward. This is also the case for the outcrops as a whole. This suggests that the energy of the fluvial system decreased with time.

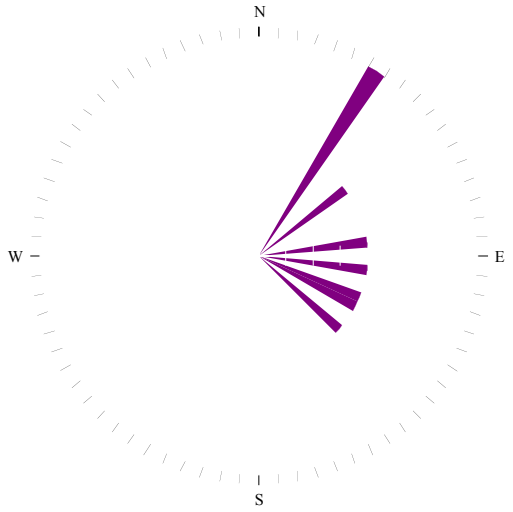

Figure 1. Rose diagram indicating a northeast paleocurrent direction.

STRUCTURE

The southeastern portion of the Australian continent is a passive margin, but seismic data suggests that the area is quite active (Gibson, et al., 1981). There are series of NE-SW trending faults in the region (Bishop, 2000). Three of these faults are high angle normal faults (approximately 80° dip) that bound the Toora Tin Fields (Figure 2). The Yarram fault is found in the northwestern section of the study area and cuts through three of the quarries. The Great Southern Workings (GSW) contains beds that are folded along the fault and dip between 36°S and 45°S (Spencer, 1955). The three quarries that contact the Yarram fault all show small scale faulting, within the gravel beds that are offset up to 15 cm. These small-scale faults are easily visible in the beds of the GSW just south of the

Yarram fault, and are contained within the folded beds.

The other two faults in the area are the Toora fault, which forms the southern boundary of the tin fields, and an unnamed fault that borders the northeastern margin.

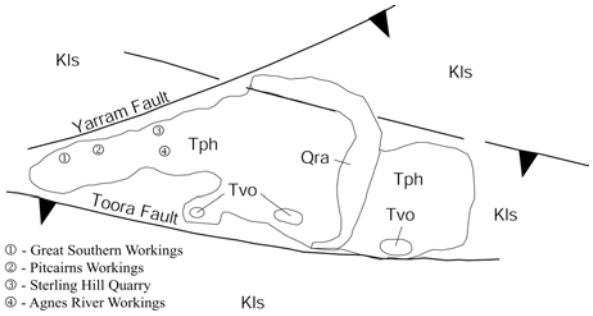

Figure 2. Map of the Toora Tin Field showing major faults, and relationships of lithologies

These three faults have been reactivated since deposition of the gravels and have isolated the gravels from their suggested source region on Wilsons Promontory. The Toora Tin Field and Wilsons Promontory are currently at similar elevations and separated by Corner Inlet, which is at sea level. If the Haunted Hills Gravel was deposited by a fluvial system, then Corner Inlet must have subsided, and the area around the Toora Tin Fields and Wilsons Promontory must have been uplifted

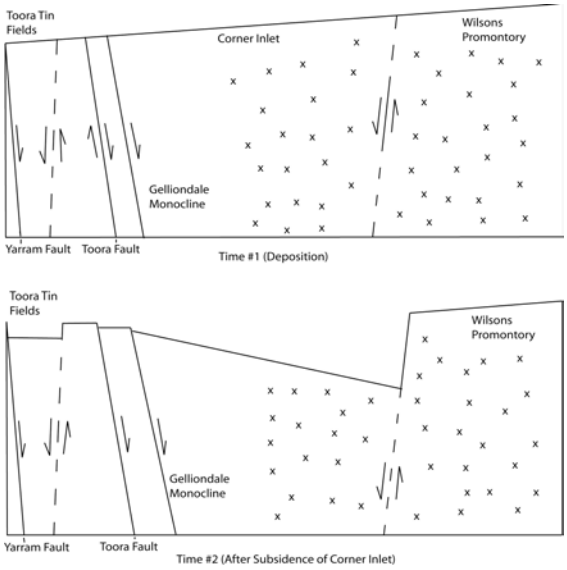

Figure 3. Subsidence of Corner Inlet and the Uplift of Toora Tin Fields and Wilsons Promontory

CONCLUSIONS

The Toora Tin Fields of Southeastern Australia form a tectonically active and complex area. Deposition of the Haunted Hill Gravels occurred during post-Eocene times due to their relationship with underlying basalts. Faulting in the area postdated deposition of the Haunted Hills Gravel as evidenced by deformation of bedding adjacent to the fault.

The source of the Haunted Hill Gravel in this area appears to be derived from Wilsons Promontory to the south. Both paleocurrent indicators (cross-bedding), and mineralogic composition suggest Wilson's Promontory as the source. More exact time constraints may be provided on the completion of cosmogenic dating.

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