1983/66. Refraction seismic investigation of an exploratory groundwater bore in dolerite at Rhyndaston

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Abstract

A groundwater bore drilled in dolerite at Rhyndaston failed to strike water and failed to intersect closely fractured dolerite as expected. Later seismic surveys showed that the dolerite in the immediate vicinity of the borehole had a velocity about triple that of nearby closely-fractured dolerite.

INTRODUCTION

An exploratory groundwater bore was drilled in Jurassic dolerite at Rhyndaston [EN313955]. The dolerite proved to be sound and relatively unfractured throughout and the hole failed to strike water. This result was unexpected. Closely fractured dolerite is exposed in a road cutting a few hundred metres to the east, and may be seen weeping water following rain. About 500 m to the west, W.R. Moore (pers. comm.) had previously conducted a seismic survey on an area mapped as dolerite by D.E. Leaman (Forsyth *et al.*, 1976) and had obtained sub-alluvium refractor velocities of around 2000 m/sec (maximum geophone - shot distance in excess of 110 m), consistent with significantly fractured dolerite.

In order to check seismic velocities of sound and unfractured Rhyndaston dolerite, a seismic refraction spread was shot across the borehole and a velocity spread was 'shot' in the fractured dolerite of the road cutting.

OBSERVATIONS AND RESULTS

On 29 September 1983 a 12-channel seismic refraction spread was shot in a north-south direction across the Rhyndaston borehole with one 14 Hz geophone per channel placed at 7.5 m intervals and 0.5 m deep shotholes placed 7.5 m from each end of the spread.

The dolerite was covered by a shallow layer of alluvium of probably varying depth. Refractor velocity segments of 3500 to 7500 m/sec were observed.

On 25 October 1983 a 12-channel seismic velocity spread was laid along the exposed fractured dolerite of the road cutting. The geophone (and channel) spacing was 2.5 m and the hammer source was located about 1.75 m from the northern end of the spread. The geophones were actually in contact with the dolerite of the cutting wall about one metre above the road surface. The hammer blows were stacked and results were repeatable. The fractured dolerite velocity was 1750 m/sec and no refractors were observed. The dolerite defect spacing was 10 mm to 30 mm.

INTERPRETATION

The borehole seismic spread time-distance refractor plot was somewhat segmented in both directions. However, we appeared to be dealing with nothing more than a two layer case and the refractor segmentation was probably due to variable velocity and/or depth of alluvium. The alluvium surface was mildly irregular and the underlying dolerite surface may also be irregular. Despite the segmentation, a quite good single straightline

refractor velocity fit was made in each direction. The straightline north to south velocity was 5700 m/sec and the reverse fit was 4750 m/sec. Treating the time-distance seismic plot as a two-layer updip-downdip case and using an alluvium average velocity estimate of 840 m/sec, the resultant refractor velocity was 5250 m/sec. Sound, relatively unfractured dolerite is known to have a seismic velocity of this order.

The velocity spread across the fractured dolerite was not complicated by an overlying layer and the results were unambiguous. A single layer only was observed with a seismic velocity of around 1750 m/sec. At some point the dolerite of the road cutting will grade west into the unfractured dolerite of the borehole. If we assume a two layer case with a sharp boundary and an unfractured dolerite velocity of 5250 m/sec, then the minimum thickness of fractured dolerite west of the velocity spread will be 10.5 m.

CONCLUSIONS

The seismic results have confirmed expected velocities for sound and very fractured dolerite, and have confirmed the absence of relatively fractured dolerite in the immediate vicinity of the groundwater bore. It is no longer considered that the low velocities of the Moore seismic survey are indicative of the presence of the same zone of fractured dolerite as that visible in the road cutting. The fractured dolerite may be in the zone of a fault or a major joint. The Moore survey may have detected another such zone, or the dolerite at that location (a depression) may be deeply weathered. Alternatively, as no dolerite is evident in the immediate vicinity of the Moore survey site, it is possible that there are sediments beneath the alluvium, although S. Forsyth (pers. comm.) considers this unlikely.

Had the groundwater bore seismic survey been carried out prior to drilling the hole, expectations of obtaining groundwater would have been significantly lower.

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