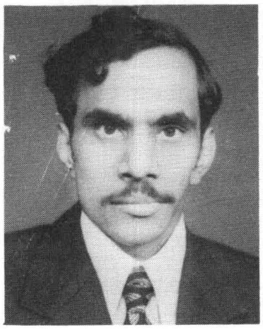

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Use of geophysics for the location of saline groundwater inflow to the Murray River east of Mildura

J. A. Odins, R. M. Williams and D. J. O'Neill

Introduction

The River Murray forms the border between New South Wales and Victoria, and crosses South Australia on the final part of its 1600 km route to the sea. The salinity of the Murray increases downstream, as is the case with most large rivers of the world. However, such salinity variations are not smooth. Gutteridge *et al.* (1970) noted that in one particular 4.5 km stretch of the river near Mildura, 80 tonnes of salt per day were entering the Murray from an unknown source. This was particularly apparent in drought years and attributed to the influx of saline groundwater. A closer look at this area forms the subject of this paper.

Study area near Mildura

The study area is located in the Murray Basin, which covers parts of New South Wales, Victoria and South Australia (Fig. 1). The Murray Basin (an area of 300 000 km^2) contains a sequence of Tertiary deposits with a maximum known thickness of 600 m, mostly of marine origin. The basal Renmark Group contains the non-marine Warina Sand and Olney Formation and is more than 300 m thick near the south-western corner of New South Wales. This group is overlain by marine deposits of the Murray Group and the discomformably overlying Bookpurnong Beds and Parilla Sand.

Gutteridge *et al.* pinpointed the area of high saltwater inflow at Lambert Island (20 km upstream from Mildura), and showed that the maximum rate of inflow occurred during the drought period between October 1967 and April 1969. There are several mechanisms which generally contribute to salinity increases. These are:

(1) the effects of evaporation;
(2) drainage flow from installed drainage systems;
(3) the effect of the river channel itself as a drain in collecting seepage flows from irrigation systems;
(4) the entry into the river channel of regional seepage flows;

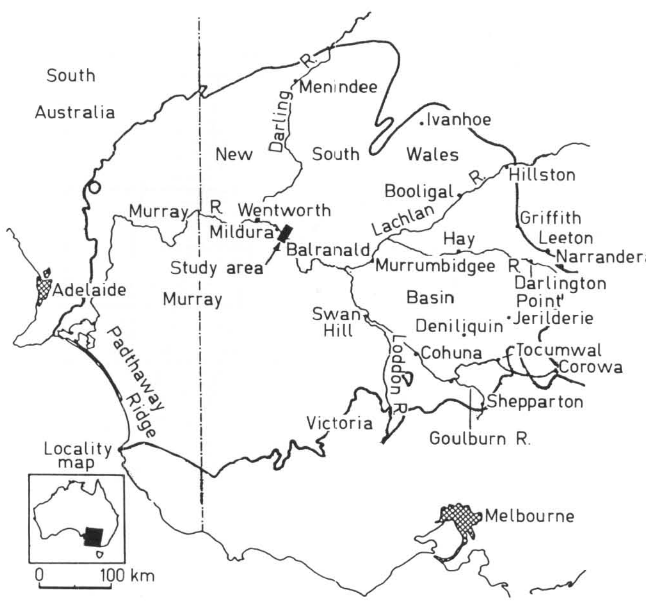

Fig 1 Location of survey area near Mildura, NSW.

(5) the weathering and partial solution of suspended matter as the river progresses to the outlet;
(6) entry into the river of surface flows as in storm drainage and natural creeks flowing through saline lands.

Figure 2 shows that during the drought year for this particular area, regional seepage flows were the main source of salt inflow. Subsequent studies by the Water Resources Commission revealed that the water table associated with the Parilla Sand in the vicinity of Lambert Island has a strong slope towards the Murray River impressed on the regional west and north-west slope. The water table and the area of salinity increase are shown in Fig. 3. It was also found that pressure heads in the deeper part of the Parilla Sand were higher than the heads in the shallower aquifers. The area in which this upward gradient occurs extends along the 4.5 km length of high salinity gain but the gradient is reversed to the west of the accession zone.

As the study area is located near the hydrodynamic centre of the Murray Basin (Williams 1983) groundwater outflow could be expected in topographically low areas such as river beds and lakes. As shown by the water table contours this is indeed the case at the study site. Nevertheless, at this stage of the investigation it was still not clear why the influx of salt water was anomalously high at this particular stretch of the river.
river.

Topography and geophysics

The land surface in the study area is dominated by general east-west trending sand dunes which have an average height

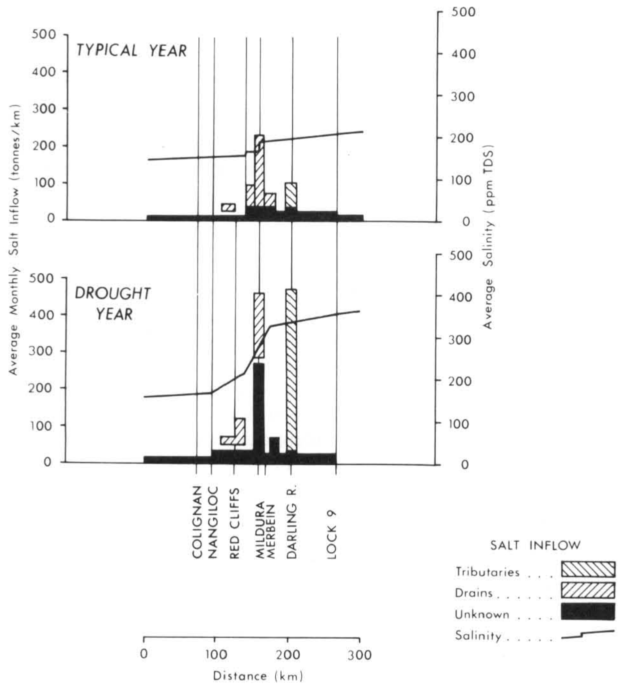

Fig 2 Salt inflows and salinity profiles for the River Murray (after Gutteridge *et al* 1970). Note the large increase in saltwater inflow from an unknown source during the drought year.

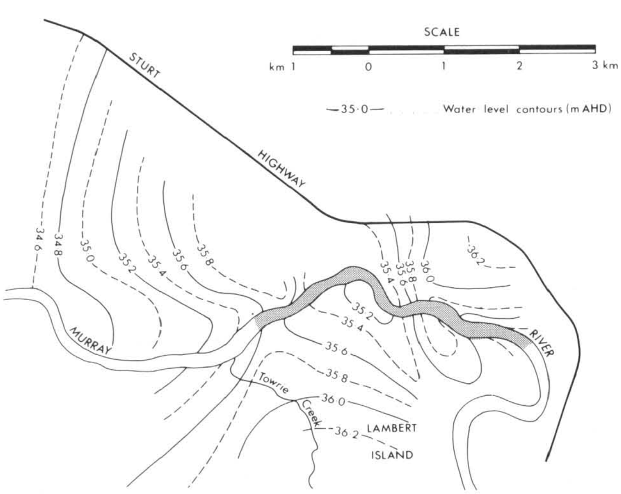

Fig 3 Water table contours at Lambert Island near Mildura, NSW. The shaded part of the river shows the location of maximum salt inflow.

difference of 8 m between crest and interdune trough. The floodplain associated with the river is terraced, but is generally flat. However, a more detailed appraisal of the topography in this region under investigation showed the existence of substantial NNE trending land ridges, hundreds of kilometres long, rising to about 50 m above the plain (Fig. 4). One such ridge appears to terminate 20 km north of Lambert Island.

The gravity trend pattern in the region (Wellman 1976) has a similar general direction (Fig. 5), suggesting the possibility that the surface features are an expression of some deep seated structure. Seven seismic refraction surveys, each approximately 15 km long, were conducted across the surface ridges to check this hypothesis. The existence of basement highs beneath the surface ridges were confirmed and a typical exam-

Fig 4 Location of land surface ridges in the Mildura area, NSW.

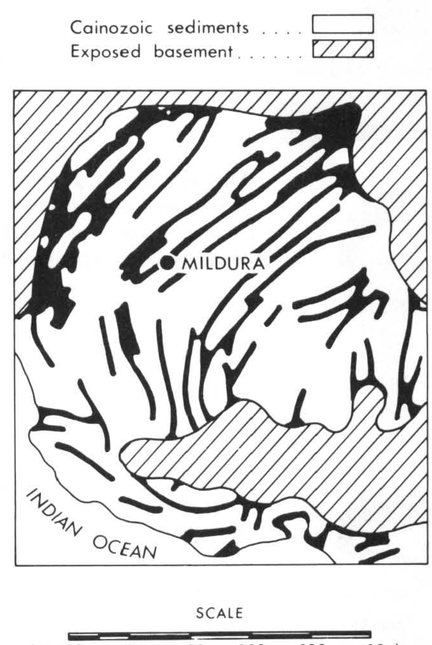

Fig 5 Gravity trend pattern, Murray Basin (after Wellman 1976).

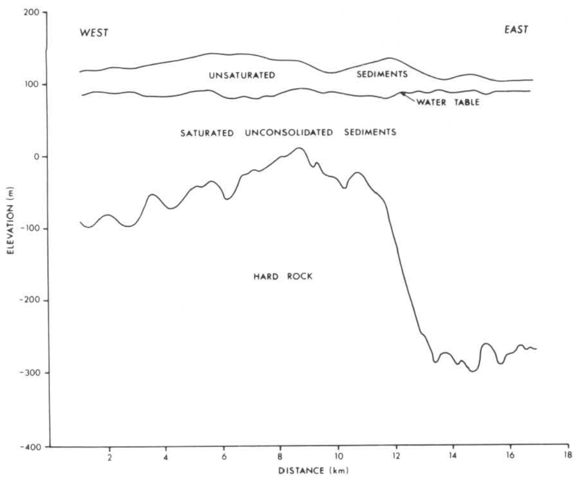

Fig 6 Seismic refraction section showing a surface land ridge located over the basement high.

ple of such correspondence is illustrated by the seismic section in Fig. 6. The geophysical work together with subsequent test drilling located the southern extent of the NNE trending pre-Tertiary bedrock ridge, which was found to be truncated on the NSW side 3 km north of the Murray River. Subsequent drilling showed slight faulting of the Tertiary sediments, resulting in partial occlusion of the Parilla Sand, and the total occlusion of the basal, non-marine Renmark Group by the bedrock ridge created by the upthrown fault-block. This has the effect of modifying the westward groundwater flow as well as causing some upward groundwater flow due to the respective partial and total occlusion of the aquifers. Thus it was determined that the observed groundwater flow pattern at Lambert Island responsible for the anomalously high influx of saltwater was primarily due to the intersection of the Parilla Sand watertable by the bed of the Murray River, and secondarily by enhanced upward movements of the groundwater caused by occlusion of the aquifer system by the basement ridge.

Conclusion

Examination of the mode of deposition of Tertiary sediments, surface topography and gravity trend patterns suggested the existence of basement highs in the vicinity of Lambert Island, near Mildura. Seismic refraction and test drilling confirmed the presence of a pre-Tertiary ridge which is responsible for the distortion in the ground water flow pattern, and which increases the rate of anomalous influx of salt water into the Murray River at the study site.

Acknowledgments

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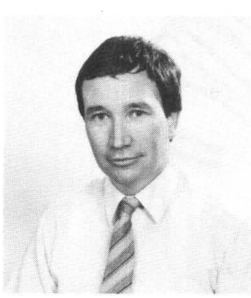

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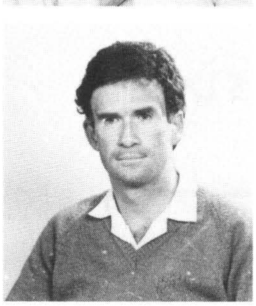

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