SALINE PLAYA-GROUNDWATER INTERACTIONS IN THE WESTERN DISTRICT OF VICTORIA

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There are a number of saline playas east of Lake Corangamite in the Newer Volcanics Province of western Victoria that are characteristically rich in bicarbonate and which also are the sites of authigenic dolomite ($CaMgCO_3$) and magnesite ($MgCO_3$) precipitation. These lakes (Figure 1) are also undersaturated with respect to both calcite and aragonite. Yet, there are many other lakes adjacent to those lakes that do not contain dolomite nor magnesite. The best known playa with dolomite and magnesite is Lake Beeac, which has been studied for its water chemistry, sediment composition and sedimentological history (Williams & Buckney 1976, De Deckker & Last 1988, 1989, Last & De Deckker 1990, 1992).

The area is characterized by Quaternary basalts that flowed, in places on several occasions, over a low-lying topography. The outstanding topographic features are Warrion Hill, Mt Hesse and Mt Gellibrand (Figure 2).

Thompson (1971) identified a progressive increase of salinity of shallow groundwaters away from Warrion Hill, which showed that the dolomitic lakes occurred above a very specific range of groundwater salinities (Figure 3). Thus, Thompson identified a possible link between groundwater chemistry and processes, especially knowing that the playa lakes are in fact 'groundwater windows', and the lakes chemistry and sediment compositions.

A set of piezometers was placed in the vicinity of the lakes downslope from Mt Warrion (Figure 2) in order to determine the chemistry and flow paths of the groundwater in the region, and link the latter to the water chemistry of the playas which are considered to be 'windows into the groundwater'.

The work presented here clearly identifies that the volcanic rises in the region (Figure 4), such as Warrion Hill, play a vital role in groundwater recharge first, followed by flow paths towards the depressions in the region where the playas are located.

In the recharge areas, the waters are predominantly rich in Ca and, as water progressively flows towards the playas, Ca is lost and presumably exchanged for K (Figure 5), with also a considerable enrichment with respect to Mg/Ca (Figure 6). This cationic exchange is thought to occur on clays in the subsurface, which are the byproduct of weathering of the local Quaternary basalts. Eventually, the lake waters become supersaturated with respect to Mg-rich minerals. Attempts will be

Figure 1: Oblique aerial photograph looking south showing the characteristic white colour of the dolomitic lakes with primary dolomite in suspension in the very turbid lake waters. Lake Cundare is in the forefront and the almost circular Lake Beeac. Note the colouration of the other lakes (pink for those yielding the hypersaline *Dunaliella* alga, black for other saline lakes) which do not contain dolomite or magnesite.

made also to explain the high bicarbonate contents of the waters.

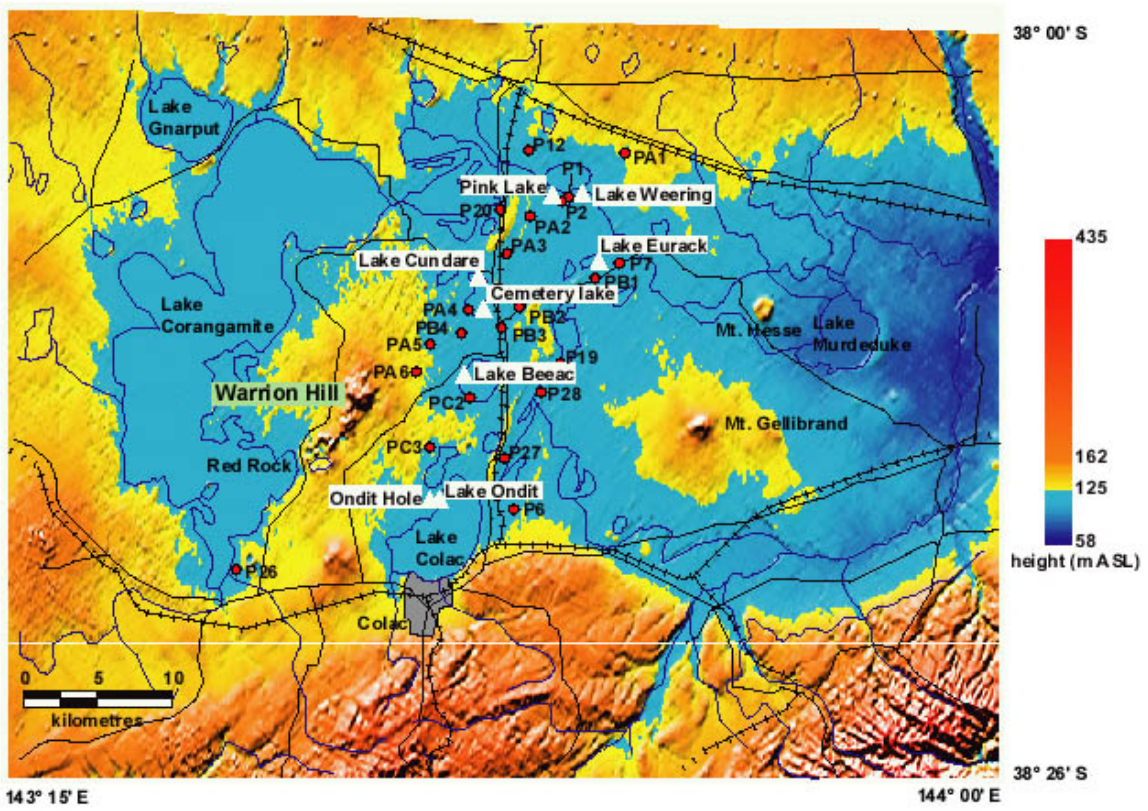

Figure 2. Digital elevation Model (DEM) map of the Corangamite region showing the location of the lakes mentioned in the text as well as the piezometers (red dots) and lakes (white triangles) for which water chemistry data are presented here. Note the presence of the 3 volcanic topographic highs: Warrion Hill; Mt Gellibrand; and, Mt Hesse.

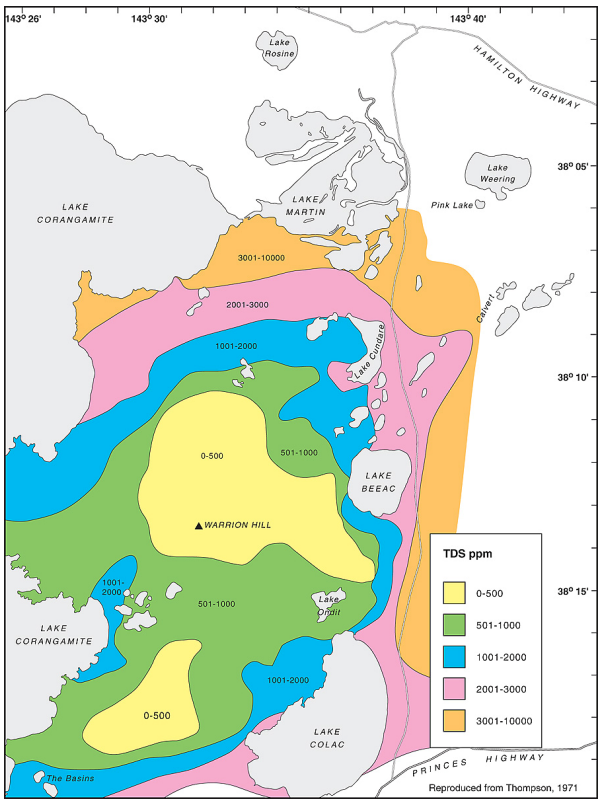

Figure 3: Groundwater map redrawn from Thompson's (1971) thesis showing the progressive salinity increase of the near-surface waters away form Warrion Hill. Note that Lakes Beeac and Cundare are located at the limit between 2 specific salinity ranges.

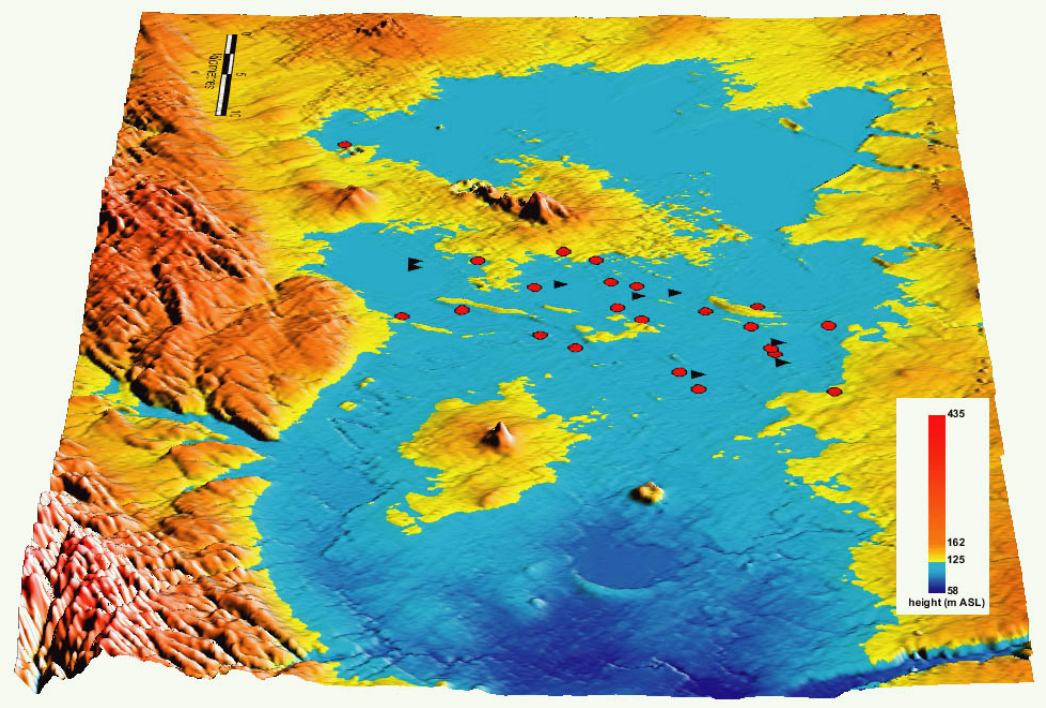

Figure 4: DEM reproduction to show the (vertically exaggerated) topographic highs (Warrion Hill, Mt Gellibrand and Mt Hesse) and the location of the piezometers (red dots) and lakes (black triangles).

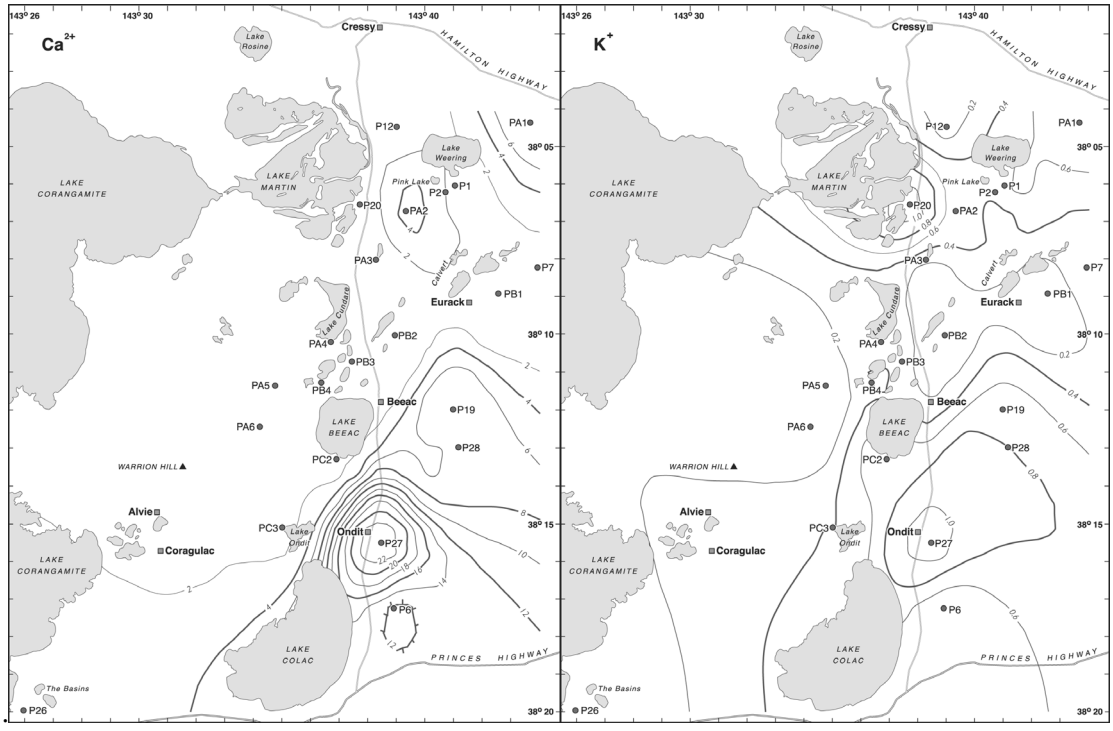

Figure 5. Plots for Ca and K [in meq/L] for the shallow groundwaters which show a progressive decrease in Ca values away from Warrion Hill matched by an increase in K. This is interpreted here as the result of cationic exchange probably on/by clays in the regolith. The piezometers are indicated by black dots.

It will be argued that water chemistry plays a major role in controlling the presence/absence of the biota inhabiting the lakes. For example, gastropods, such as the halobiont, euryhaline *Coxiella* sp., should normally

be found in such playas and yet are absent. The ostracod *Platycypris baueri*, on the other hand, is found living in the lakes, but no valves are preserved in the sediments. Such information leads to determining the role lake water chemistry has on the biota, as well as interpreting biological records in lacustrine sediments.

I will present data on the Holocene history of hydrological changes in the region that provide a better perspective for understanding the anthropogenic effects in the area on salinisation and environmental changes.

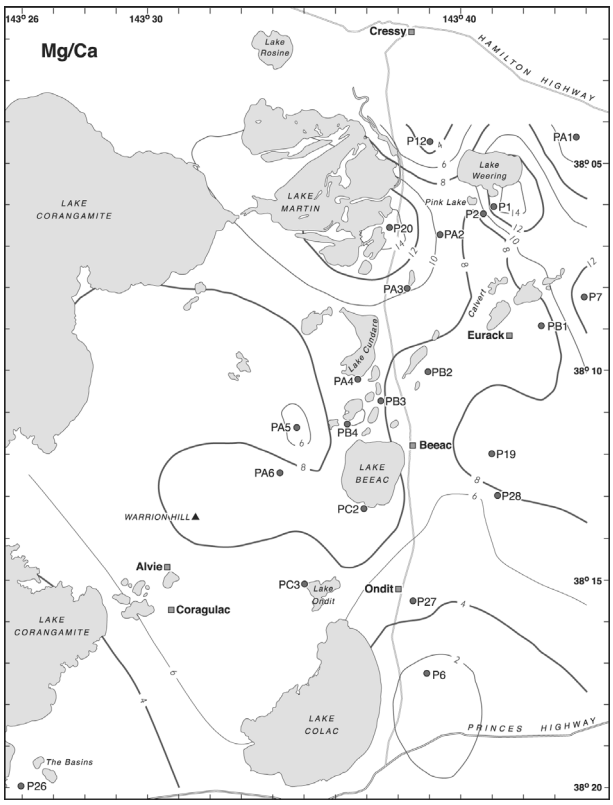

Figure 6. Plot of Mg/Ca to the waters collected from the piezometers [black dots] to show the progressive enrichment of the waters away from Warrion Hill and that are linked with the dolomite and magnesite precipitation in the playa lakes.

REFERENCES

DE DECKKER P. & LAST W.M. 1988. A new continental region of modern dolomite deposition in western Victoria, Australia. *Geology* **16**, 29-32

DE DECKKER P. & LAST W.M. 1989. Modern dolomite in continental, saline playa lakes in western Victoria, Australia. *Sed. Geol.* **64**, 223-238.

LAST W.M. & DE DECKKER P. 1990. Modern and Holocene carbonate sedimentology of two saline volcanic maar lakes, southern Australia. *Sedimentology* **37**, 967-981.

LAST W.M. & DE DECKKER P. 1992. Paleohydrology and paleochemistry of Lake Beeac, a saline playa in southern Australia. *In:* ROBARTS R.D. & BOTHWELL M.L. eds. *Aquatic ecosystems in semi-arid regions: implications for resource management.* N.H.T.I. Symposium Series 7, Environment Canada, Saskatoon, Saskatchewan, 63-74.

THOMPSON B.R. 1971. *The geology and hydrogeology of the Corangamite region*. MSc Thesis, University of Melbourne, unpublished.

WILLIAMS W.D. & BUCKNEY R.T. 1976. Stability of ionic proportions in five salt lakes in Victoria, Australia. *Aust. J. Mar. Freshwater Res*. **27**, 367-377.

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