A Pb ISOTOPE STUDY OF ANATASE IN SILCRETE

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INTRODUCTION

Silcrete is a ubiquitous regolith material found throughout Australia. Silcretes have been the subject of much work from the 1960s through to the 1980s in Australia. Yet, there is still much unknown or debated as to their genesis, age and significance in the Australian landscape. Genetic models range for evaporative processes acting in arid environments (Ollier 1978, Stephens 1971) to crystallisation in swampy environments similar to those in which coal forms (Wopfner 1978). Silcrete refers to intensely indurated rock composed mainly of quartz clasts cemented by a matrix of crystalline, crypto-crystalline quartz or amorphous silica, where induration occurred at or near the surface, due to inputs or silica from weathering, streams or ground waters (Young 1985). From stratigraphic and fossil evidence, silcretes have been broadly assigned a Tertiary age in Australia (e.g., Ollier 1991, Twidale 1983, Wopfner 1978).

The Sandstone Tank silcrete represents silicified Tertiary palaeochannel sediments (Hill & Roach 2003). The outcropping material consists of a basal conglomerate of Adelaidean metasediment gravels, grading up through smaller sized clasts to more massive, tabular silcrete at the top, and is about 6m thick. The top portion does contain some rounded quartz pebbles. The silcrete at Sandstone Tank contains possible Eocene temperate rainforest flora, preserved as impressions of leaves and twigs (Figure 1; Greenwood *et al.* 1997)

The basal gravels and larger pebbles are draped by beige-coloured geopetal cappings (Figure 2), which are composed of anatase, iron oxides and silica in varying proportions. The clasts towards the top of the conglomerate are draped by thicker caps than those at lower levels. The anatase is a late stage feature, possibly replacing clays.

Figure 1: Eocene temperate rainforest flora fossils (Greenwood *et al.* 1997) in Sandstone Tank silcrete (photo courtesy of S. Hill)

METHODS

Earlier work utilising Scanning Electron Microscopy (SEM) and Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) revealed a correlation between the abundance of anatase and U concentrations within the caps, and investigated the possibility of dating the anatase by LA-ICP-MS U-Pb

dating methods (Hill & Roach 2003, Smith *et al.* 2003). However, the problem of too much common Pb was encountered. This led to more detailed studies of the Pb isotopes using the more precise Neptune solution multicollector ICP-MS (MC-ICP-MS) at RSES.

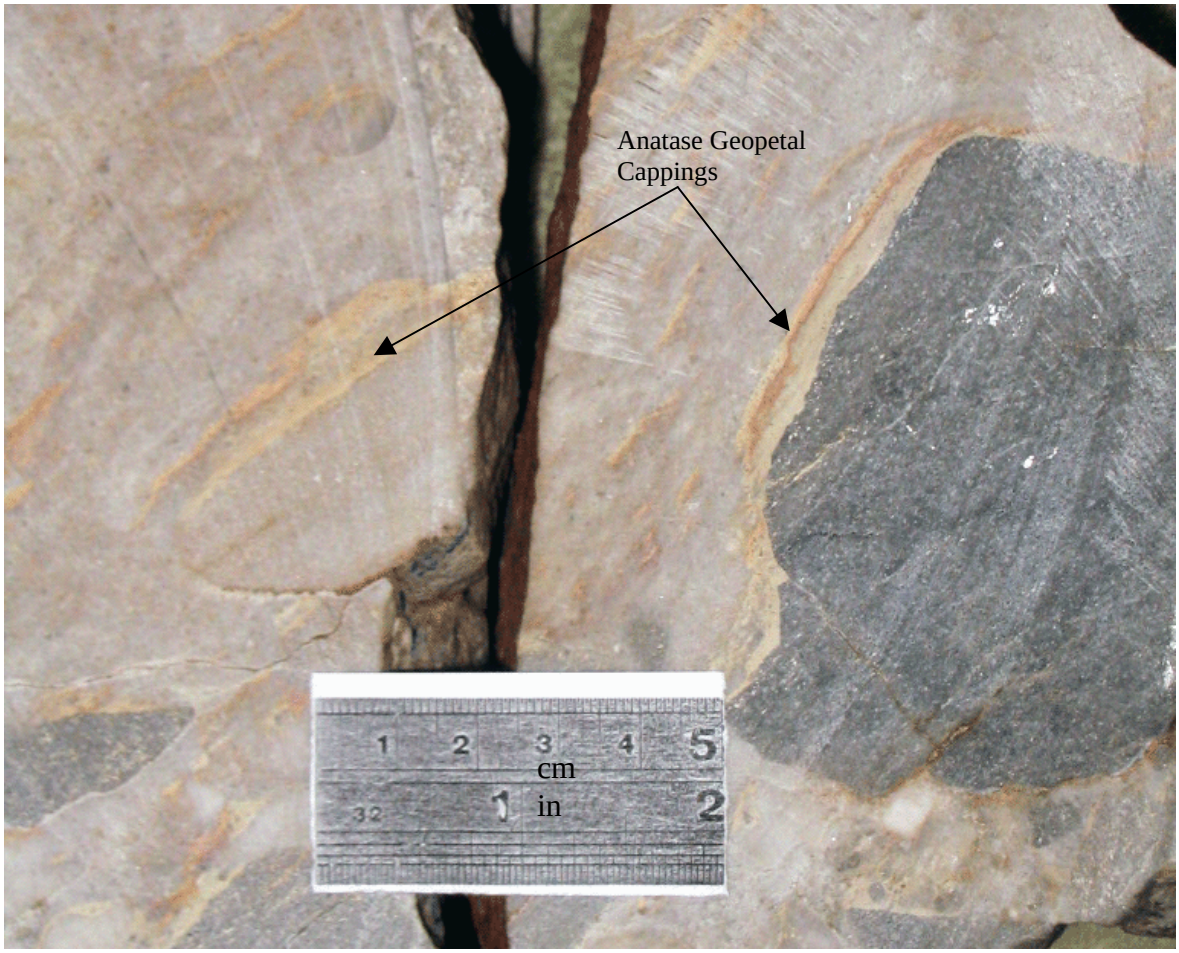

Figure 2: Geopetal cappings in the Sandstone Tank silcrete.

The anatase was prepared by first cutting wafers from the geopetal caps, coarse crushing in a piston crusher and handpicking ca. 0.1g of sample. The resulting separates were weighed, then dissolved in HF/HNO_3 in Teflon bombs at 200°C overnight. The solutions were evaporated to minimum volume, brought up to volume in 6N HNO_3, and then boiled to minimum volume. The resulting sample was then brought up in 2% HNO_3, and spiked with a Tl tracer to monitor mass fractionation in the ICP. The final stock solution was made up to ca. 10g (a dilution of ca. 100x). From this stock solution, both unspiked and spiked solutions were prepared for analysis.

Analysis was carried out on the Finnigan Neptune MC-ICP-MS, using an Apex sample introduction system over three days. First, the unspiked Pb aliquot was analysed. Throughout the run, SRM 981 Pb standard was also measured to monitor precision and accuracy. Following this, the spiked aliquot was analysed for Pb, along with SRM 981 and a spike calibration solution, the U and Th were measured from the same spiked aliquot, with the standard being a solution prepared from the 620 Ma ALH uraninite.

RESULTS

The results of the MC-ICP-MS analysis are summarised in Table 1. All ratios are background and mass fractionation corrected. Errors are reported as standard errors, derived from the instrumental measurements, except for U/Pb ratios, which were determined by concentrations, and the standard error as the square root of the sum of squares of the individual errors.

Table 1: Sandstone Tank anatase Pb results.

Sample	Pb ppm	Common Pb#	206/204	+/- std err	207/204	+/- std err	208/204	+/- std err	U ppm	238/204	+/- std err
SSTPb1.1	0.721	0.631	20.689	0.033%	15.872	0.033%	39.788	0.033%	7.258	4.798	0.398%
SSTPb1.2	0.968	0.848	20.413	0.019%	15.832	0.019%	39.685	0.019%	5.850	2.875	0.260%
SSTPb2.1	0.558	0.490	19.548	0.040%	15.836	0.040%	39.638	0.040%	7.291	6.203	0.367%
SSTPb2.2	0.519	0.454	19.911	0.042%	15.903	0.043%	39.735	0.042%	7.587	6.965	0.365%
SSTPb4.2	0.897	0.788	20.337	0.023%	15.917	0.022%	39.596	0.023%	6.577	3.479	0.243%
SSTPb5.2	0.181	0.162	20.021	0.129%	15.809	0.131%	38.935	0.129%	7.697	16.871	0.444%
SSTPb7.1	0.406	0.362	24.271	0.049%	16.234	0.049%	38.967	0.049%	12.807	14.737	0.275%
SSTPb7.3	0.781	0.680	20.204	0.028%	15.968	0.029%	39.980	0.029%	7.061	4.329	0.322%

DISCUSSION

The Pb data from the Sandstone Tank silcrete plot as mixing lines on conventional $^{207}Pb/^{204}Pb$-$^{206}Pb/^{204}Pb$ diagram (Figure 3). The mixing line shown in the $^{207}Pb/^{204}Pb$-$^{206}Pb/^{204}Pb$ diagram passes through the Broken Hill Ore Pb reported by various workers (Albarede & Juteau 1984, Cumming & Richards 1975, Richards 1986, Stacey & Kramers 1975). The significance of this result will be discussed. There is little correlation between the Sandstone Tank results in the $^{208}Pb/^{204}Pb$-$^{206}Pb/^{204}Pb$ (Figure 4).

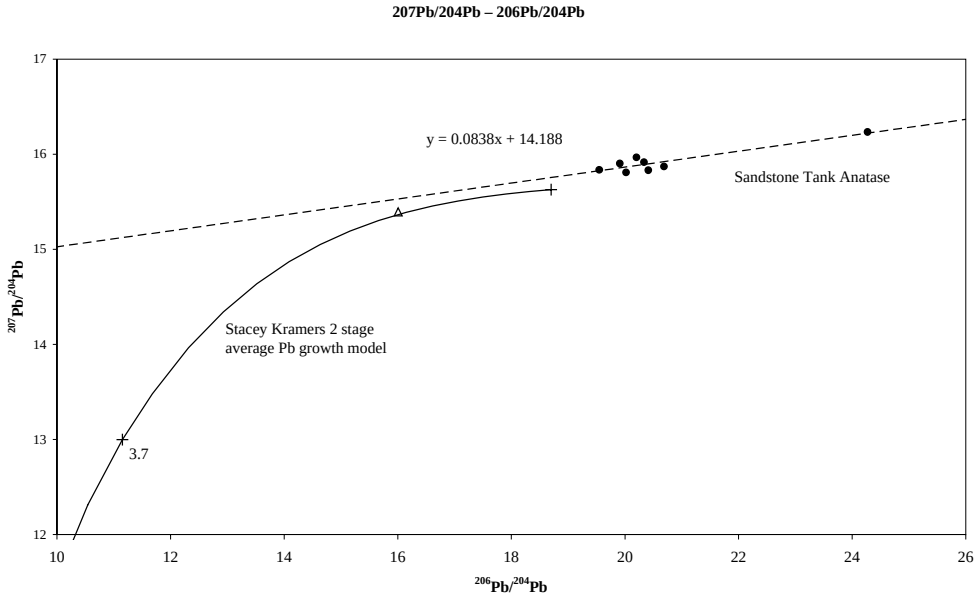

Figure 3: $^{207}Pb/^{204}Pb$-$^{206}Pb/^{204}Pb$ diagram open circles were not included in the calculation of the regression line.

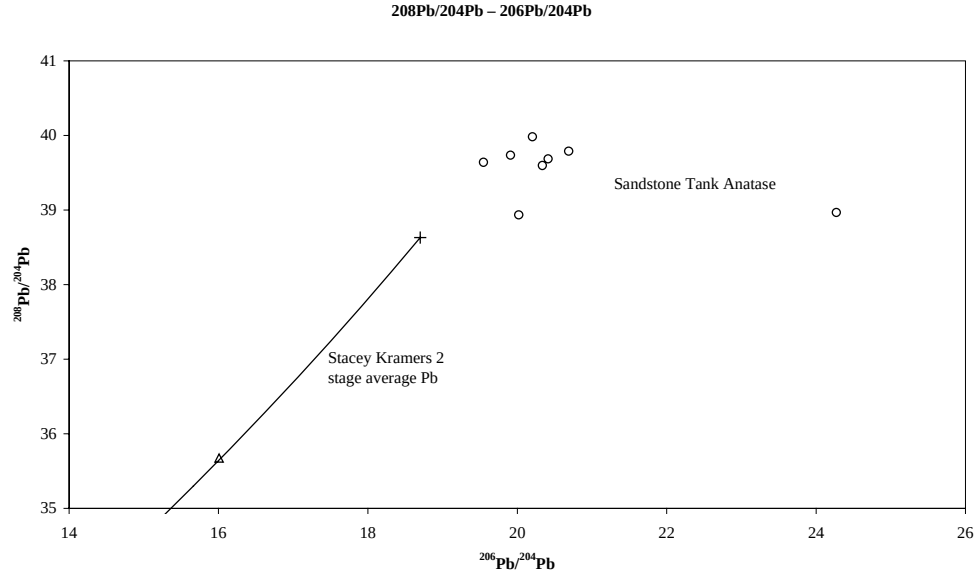

Figure 4: $^{208}Pb/^{204}Pb$-$^{206}Pb/^{204}Pb$ diagram.

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