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PROGRESS REPORT FOR AINGRA09060

PROJECT TITLE	Dust sources and processes of dust production: their contribution to the NW passage of dust over Australia	
INVESTIGATOR(S)		**Institution and Department**
Chief Investigator	**Dr Richard Greene**	The Fenner School of Environment & Society, Australian National University
Other Investigators	Dr. R. Cresswell: CSIRO L&W Mr. Keith Scott: CSIRO DEM Mr. E. Stelcer: ANSTO	
Students	Lance Karlson FSES honours student for 2009/2010	
ANSTO Investigators	Ed Stelcer	
Specialist Committee	E	

SCIENTIFIC OBJECTIVES

The objectives of this research are to (i) determine likely dust sources in Australia, particularly those that contribute to the NW dust path, and (ii) understand the processes in these source areas that contribute to dust production.

PROGRESS REPORT and RESEARCH OUTCOMES

Note that the honours student Lance Karlson working on this project only commenced his studies in July 2009. As a consequence this progress report only covers the first 6 months of the project. Part of the work reported below has already been presented at two science conferences (see Publications). The complete results from the project will be presented in the honours thesis which is due to be submitted for examination in May 2010. The project has also resulted in CSIRO continuing to collaborate in the next stage of the project, for which provisional funding for 2010 has been received (Award No. ALNGRA10096P).

Ion Beam Analysis (IBA) and the laser integrating plate method (LIPM) have been used at ANSTO to analyse the elemental and black carbon characteristics respectively of rainwater-derived aeolian dust samples from eight sites across NW Australia and from within the Lake Eyre Basin. These rainwater samples were collected monthly over one year by the Bureau of Meteorology (BoM), analysed for ion chemistry and stable isotopes by CSIRO Land and Water at Adelaide and then filtered at the ANU for IBA and LIPM. Scanning electron microscopy (SEM) was also used at the ANU to determine the morphological characteristics of selected samples. Particular attention was given in this project to improving sample preparation techniques, as doubts had been raised about the accuracy of IBA data in previous studies where rainwater was used as a source of aeolian material.

In terms of preparing samples, our results have indicated that for accurate IBA of rainwater samples, a method involving a syringe and filter holder technique (for 25 mm filters) is highly effective, as it allows increased pressure to be applied during the filtration relative to a vacuum pump (alternative method) and produces a high concentration and uniform distribution of particles across the filter. This method allowed detailed SEM examination of the morphology of the dust samples and was shown to produce the most accurate results using IBA. In Fig. 1a-c, a sample from Alice Springs is used to exemplify the variation in IBA results from different filtering methods. Here, only soil-derived elements are shown and all elemental concentrations are normalized to 1 in order to effectively compare results. In Fig. 1a, the sample was filtered using a standard vacuum pump through a 47mm filter; in 2b, the sample was also filtered using a vacuum pump method through a 47mm filter, however only the PM_{10} fraction was filtered; in 2c, the PM_{10} was filtered using a syringe and filter holder technique through a 25mm filter.

The results show that Methods 1 and 3 (in which the corresponding SEM images in Fig. 2 a) and c) respectively show a high concentration of particles) produced comparable results. However, Method 2, with a poor distribution of particles shown in its corresponding SEM image in Fig. 2 b), produced highly disparate results. This indicated that the method was insufficient in providing accurate IBA data. The fact that Al concentration exceeds Si in Method 2 (a highly improbable result) further confirms this finding. These results allowed a greater level of confidence in determining which data to focus upon during data analysis, and will be useful for those attempting similar work.

IBA results were further subjected to a range of data analysis techniques including soil normalisation, linear regression analysis, total and regolith mass reconstructions, chemical index of alteration (CIA) and enrichment factor analysis. Using Si as a regolith reference element, linear regression analysis revealed very strong correlations of Si with other regolith elements (such as Al, Fe, Ti and Mn) as shown in Fig. 3. However, when the elements Na and Ca were initially subjected to linear regression against Si, poor correlations were obtained. Further investigation revealed that two sources of these elements probably existed (Fig. 4). It has therefore been inferred that both marine and regolith sources have contributed to the dust composition, or that evaporates containing high concentrations of Ca and Na, such as gypsum ($CaSO_4.2H_2O$) and halite (NaCl), are a strong contributor to the dust composition.

Current analysis is focused on drawing the possible links between dust analyses from source areas such as Lake Eyre Basin and dust from across the western half of the Australian continent. So far results indicate that the Lake Eyre Basin is a source of dust across the west, but that emissions are dependent upon season, and that the chemistry of the dust is altered during transport.

DATA

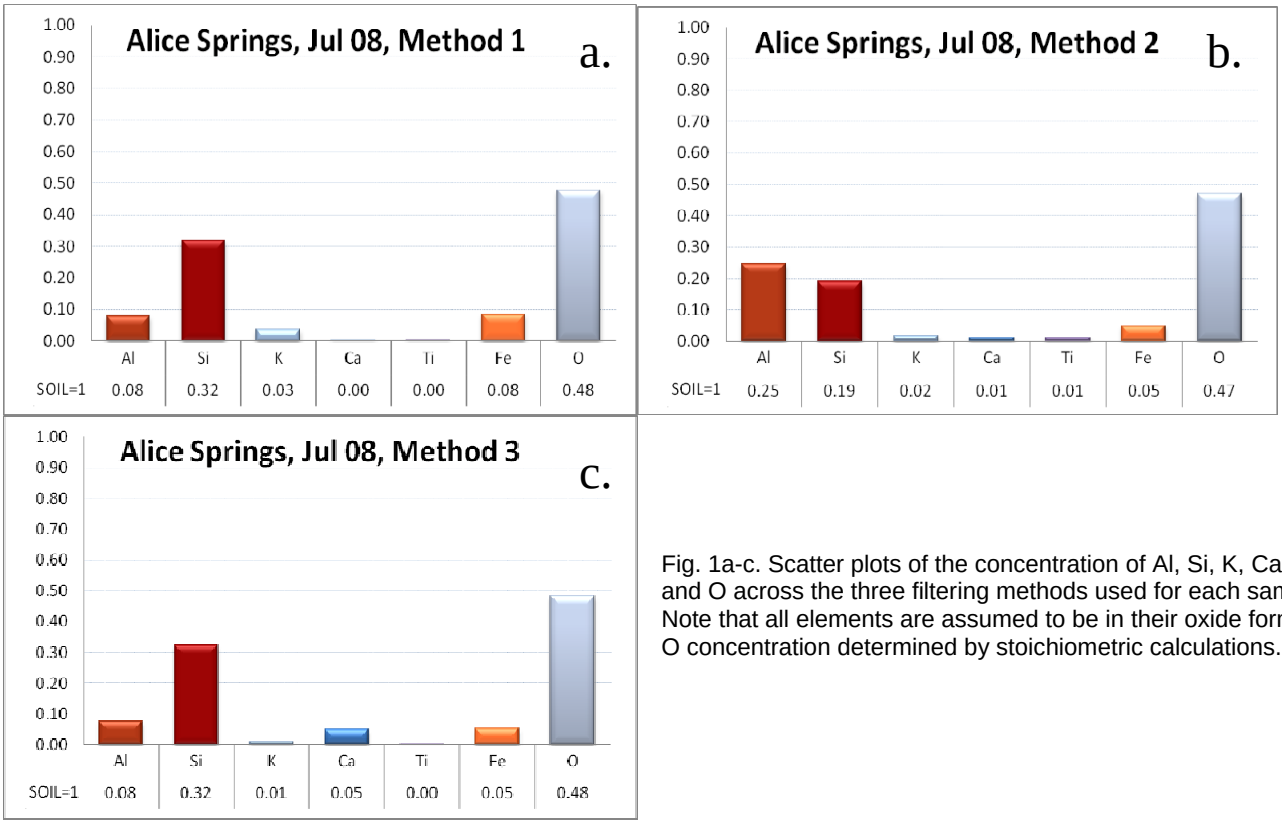


Fig. 1a-c. Scatter plots of the concentration of Al, Si, K, Ca, Ti, Fe and O across the three filtering methods used for each sample. Note that all elements are assumed to be in their oxide form, with O concentration determined by stoichiometric calculations.

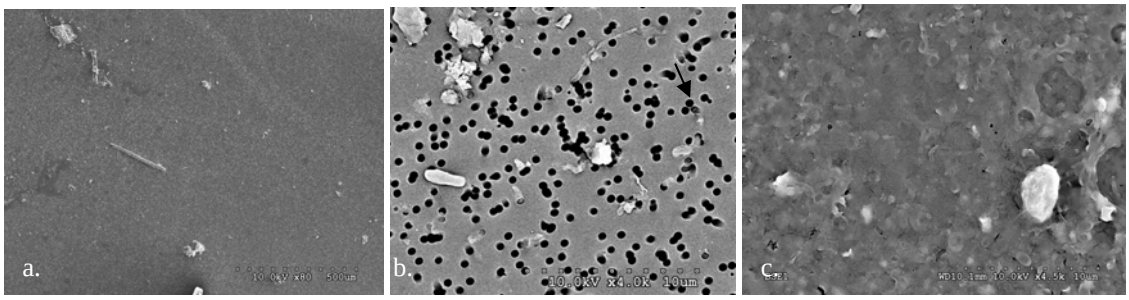


Fig. 2. SEM images of Alice Springs, July 08 rainwater sample. a). x80 Method 1. Vacuum pump, 47 mm filter, total sample. b). x4000 Method 2. Vacuum pump, 47 mm filter, PM_{10} fraction (note black dots are vacant pores). c). x4500 Method 3. Syringe and filter holder, 25 mm filter, PM_{10} fraction.

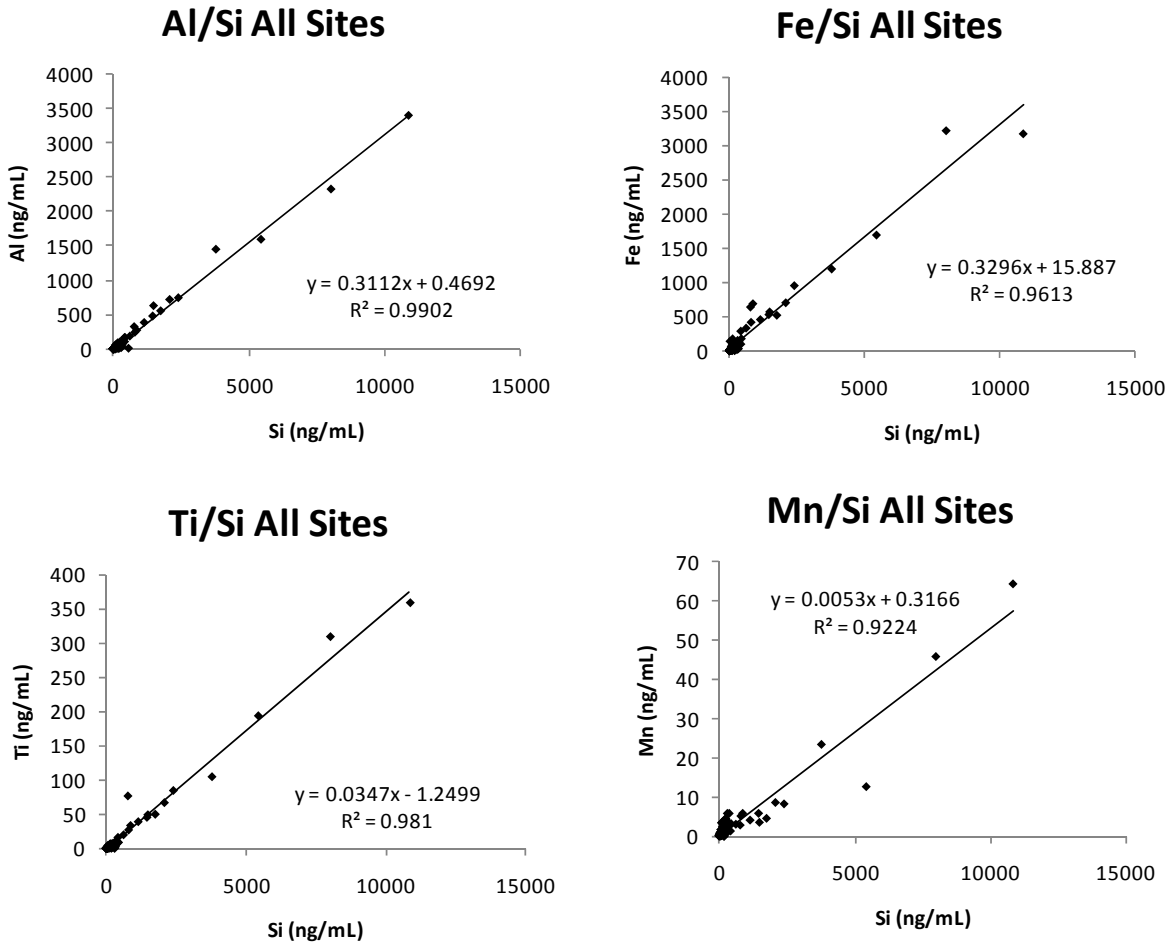


Fig. 3. Major regolith elements plotted against Si.

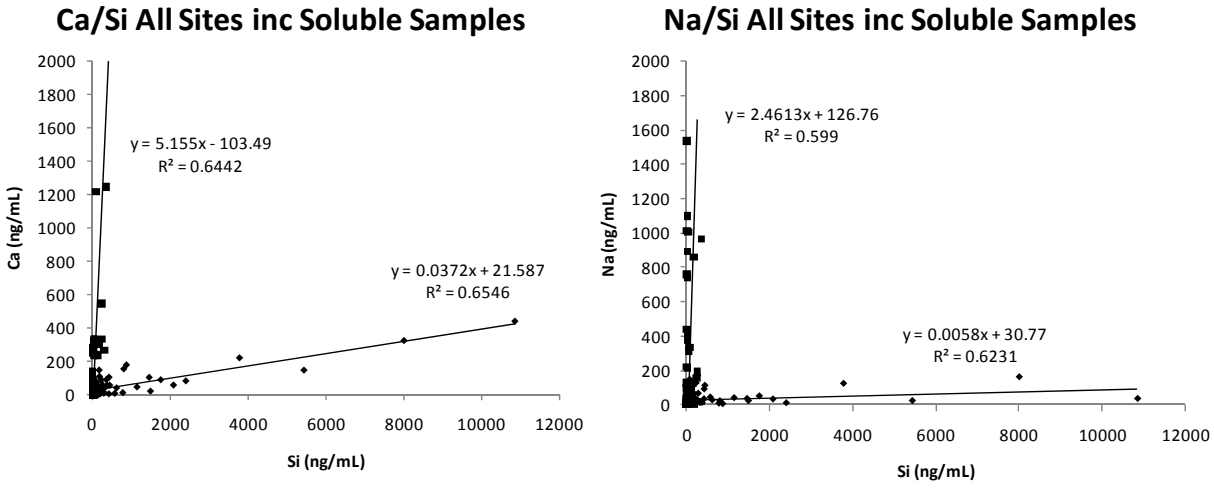
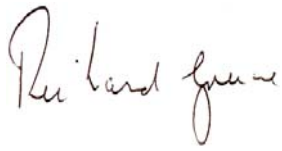


Fig. 4. Ca and Na plotted against Si: two species sources revealed. Steep trend line inferred to be a 'marine' or soluble source, while the lower trend lines appear to indicate an insoluble felspathic/regolith source.

Signature of Investigator preparing the report for **After signing this report please fax this page with your signature for our files**	**Proj: AINGRA09060** **Date: 8th Feb. 2010**
	
PUBLICATIONS / REPORTS arising as a result of your work.	

AINGRA09060: Karlson, LR, Greene, RSB, Scott, KM, Stelcer,E, Atanacio, AJ, and Cresswell, R. 2009. Application of IBA and Refined Sample Preparation Techniques to the Study of Aeolian Dust Samples from Northwest Australia; Conference Proceedings; 16th AINSE Conference on Nuclear and Complementary Techniques of Analysis, 25 - 27 November 2009 at Lucas Heights, Sydney (Submitted) (s).

A presentation of the same name was made at this conference.

AINGRA09060: Karlson, LR, Greene, RSB, Scott, KM, Stelcer,E, and Cresswell, R. 2009. Source Areas and Characteristics of Aeolian Material across Northwest Australia. Conference Abstracts, Atmosphere, Oceans, Environment and Society (AMOS) 17th Annual Conference, 27th-29th January 2010, the Australian National University, Canberra (s).

PhD STUDENTS

Lance Karlson: Honours Student. Lance is currently writing his thesis, which is due May 2010. The title is not yet decided.