

Assessing the effects of grain size on chemistry — results from the GSWA's Regional Regolith Geochemical Program, Western Australia

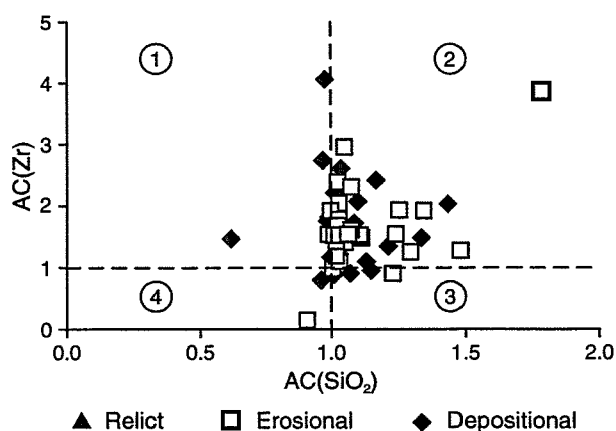
by

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Prior to implementation of geochemical surveys, orientation programs are usually carried out to optimize the approaches to field work and analysis. In the case of regional-scale geochemical surveys involving relatively low density sampling over large areas, orientation programs may not be carried out because of limitations imposed by time and resources. Instead, a uniform approach is adopted based on published data from similar-scale surveys, and local experience in the areas under consideration. This is the case for the GSWA's regional regolith geochemical program, where regolith is sampled at a uniform density of one sample per 16 km², utilizing a variety of sample media, including stream sediments, sheetwash, sandplain, and lake sediments, depending on local conditions. In order to minimize the effects of heterogeneity introduced by large fragments ('nugget effect'), and avoid excessive dilution by fine-grained eolian material, the 2–0.45 mm fraction is analysed for all samples.

In order to review the appropriateness of this grain size fraction on chemistry, the <2 mm and <0.45 mm fractions of fifty-four samples from eleven 1:250 000 mapsheets have been further analysed. The mapsheets span a variety of lithologic and physiographic associations from granite–greenstones of the Archaean Yilgarn Craton, to more diverse assemblages of dominantly siliciclastic sedimentary rocks of the Capricorn Orogen. Each sample was analysed for a variety of major element-oxides and trace elements, including Au, As, Zr, and Cr. In comparing the <2mm and 2–0.45 mm fractions, the highest Au concentrations are found in the 2–0.45 mm fraction for more than 80% of samples, with no apparent control in terms of mapsheet (i.e. geology), regolith type, or sample medium. In contrast, for more than 70% of samples, SiO₂ is higher in the <2 mm grain size fraction, although many samples plot close to a 1:1 line. This suggests that (a) Au is found as either coarse-grained particulate material, or as fine-grained material deposited on coarse-grained fragments, and (b) higher SiO₂ in the <2 mm size fraction results from eolian input or concentration of quartz through loss of more labile components. Eolian input is more likely, as indicators of weathering are similar for both grain size fractions, and increases of

up to 50% in SiO₂ in the <2 mm size fraction are inconsistent with the stability of quartz in the weathering environment. Plots showing the ratios of analyte concentrations in the respective grain size fractions can be used to further evaluate changes in chemistry according to grain size. In Figure 1, the variable AC is the ratio of the analyte concentration in the <2 mm fraction to the concentration in the 2–0.45 mm fraction. In the case of Zr and SiO₂, analyses plot at either AC(Zr) and AC(SiO₂)>1 (quadrant 2: eolian input of quartz and zircon in the fine-grain size fraction) or AC(SiO₂)=1 and AC(Zr)>1 (join of quadrants 1 and 2: no eolian input of quartz, but eolian input of zircon). In contrast, when Cr is compared to SiO₂, analyses show increase in Cr with no change in SiO₂ in the <2 mm size fraction, or no change in Cr or SiO₂, or some dilution of Cr by addition of SiO₂. The implication here is some mechanical breakdown of



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Figure 1. AC is the concentration of either Zr or SiO₂ in the <2 mm fraction divided by the respective concentration in the 2–0.45 mm fraction (AC(Zr) and AC(SiO₂) respectively) for regolith samples according to regolith type. Circled numbers are quadrant designations, discussed in text

chromite leading to a relatively higher concentration in the <2 mm size fraction, or no change at all, or dilution of chromite in the <2 mm size fraction by addition of eolian-sourced quartz.

Arsenic is a commonly used pathfinder element for Au mineralization. The behaviour of As in relation to SiO_2 is in marked contrast to that of either Zr or Cr, in that As is lower (rarely higher) in the <2 mm size fraction (with no change in SiO_2), or is diluted by addition of quartz.

The behaviour of Zr, Cr and As in relation to SiO_2 illustrates no consistent pattern in regolith chemistry

according to either sample medium, or regolith type, or mapsheet (geology). Within-mapsheet variation is commonly observed. The only element to show consistent behaviour is Au, which appears to be in higher concentrations in the 2–0.45 mm size fraction. Thus, no one grain size fraction is suitable for all analytes examined in the GSWA's program. This, taken in conjunction with the need for rapid release of data, and maximizing the use of resources, validates the current approach of using the 2–0.45 mm grain size fraction for multielement analysis in the GSWA's Regional Regolith Geochemical Program.