INTRODUCTION

Overbank sediment samples collected near the outlets of large drainage basins are commonly used to obtain regional geochemical information (e.g. McConnell et al. 1993; Demetriades 2008). Having been deposited on floodplains in low energy environments adjacent to major drainage channels, they are fine-grained and have the potential to represent large areas of, or the average composition of, entire catchments. Low density representative sampling has critical implications for geochemical surveys covering large areas. Such a survey is currently being carried out for the whole of Australia (Caritat et al. 2008). This paper describes some of the results of a pilot study conducted in the Thomson region, in north-western New South Wales, as a forerunner to the national survey.

GEOLOGICAL SETTING

LOCATION

The Thomson project area covers an area of 154,521 km² and is located in northwestern New South Wales (Figure 4). It contains the Thomson Orogen, which is one of the most poorly understood orogenic belts in Australia due to its remoteness and the degree of surficial cover. Named after the Thomson River in central Queensland, it is part of the greater Tasmanides of Eastern Australia.
GEOLOGY

Various mineral prospects and minor metal occurrences are found in the study area, including Pb, Zn and Sn deposits north-east of Broken Hill, Au deposits near Tibooburra and Au, Cu and Pb deposits north of Cobar (Figure 4). The area is dominated by transported regolith with minor outcrop of crystalline basement rocks. In the east, black cracking clays, clay pans and gilgai are associated with the expansive Quaternary alluvial plains of the Darling, Barwon, Bogan and Warrego River systems. There is also an area in the north-west around Tibooburra in which cracking clays are common. The alluvium of ephemeral streams in the west and south-east is principally composed of reworked Aeolian material. Erosional rises and plains in the centre of the study area north of White Cliffs relate to silicified palaeodrainages. Calcareous earths comprise a large part of the landscape in the south-west.

Fig. 4. Catchment outlet sediment sampling sites and known mineral occurrences, Thomson Orogen, New South Wales, Australia.

Fig. 5. Geochemical map of Cu concentration in <180 μm fraction of the bottom outlet sediments (BOS), with known Cu occurrences, over the 1st Vertical Derivative of Total Magnetic Intensity image.

Fig. 6. Geochemical map of Pb concentration in <180 μm fraction of the bottom outlet sediments (BOS), with known Pb occurrences, over the 1st Vertical Derivative of Total Magnetic Intensity image.

Fig. 7. Geochemical map of Au concentration in <180 μm fraction of the bottom outlet sediments (BOS), with known Au occurrences, over the 1st Vertical Derivative of Total Magnetic Intensity image.
CLIMATE

The western portion of the Thomson region is classified as desert, with rainfall <250 mm/yr. The eastern portion is classified as grassland, with rainfall 250–500 mm/yr. Summers are hot and dry, winters cool. Highly variable rainfall results in ephemeral streams, particularly in the west, and many of the creeks and rivers flow only during flood events, which can be significant events. The low-gradient, sinuous and anastomosing streams, creeks and rivers broaden to include flood plains often several kilometres wide. It is during these events that fine silts and clays from the upstream catchment are deposited on the floodplains.

SAMPLING AND ANALYTICAL METHODS

Locations for the outlet sediment (overbank) samples are shown in Figure 4. In all, 99 catchments were sampled giving an average sample density of 1 site/1540 km². At most sites three samples were taken: (a) a top outlet sediment (TOS) from 0-10 cm depth; (b) a bottom outlet sediment (BOS) from ~60-90 cm depth; and (c) a shallow outlet sediment (SOS) from 10-25 cm depth specifically for MMI determinations. Two size fractions (<180 μm and <75 μm) were prepared from the TOS and BOS samples. The SOS sample for multi-element MMI (MMIM) analysis by method ME-MS17 was provided to ALS Chemex in its bulk form. Field pH, Munsell soil colour (dry & moist), EC 1:5 (soil:water), pH 1:5, XRD, laser particle size analysis, XRF (multiple elements), ICP-MS (after HNO3/HClO4/ HF/HCl digestion for multiple elements), ICP-MS (after HF/HCl/HNO3 digestion for Se), ISE (for F), GF-AAS (for Au), and ICP-MS after MMI extraction were performed. Full details of the sampling and analytical methods are given in Caritat & Lech (2007).
RESULTS AND DISCUSSION

XRF AND NEAR-TOTAL ANALYSES

Areas with high metal concentrations mostly occur close to outcrops of crystalline basement. With respect to Cu by XRF analysis, there are high values north of the Barrier Ranges (in the southwest of the study area), east of Tibooburra and north of Cobar. Cu concentration is generally higher in the BOS sample for both size fractions.

Pb was determined by ICP-MS after four acid digestion and shows elevated concentrations in the <180 μm fraction of the BOS around Cobar, and near the Barrier Ranges in the south-west of the survey area (see Figure 6). Sb, also determined by ICP-MS after four acid digestion, is also high around Cobar and on the Yancannia map sheet in the central-west. Au, determined by GFAAS, on the other hand does not show the same geochemical patterns in the two size fractions, and there is no consistent pattern across the Thomson region for this element by this method. This also applies to Ag by ICPMS after four acid digest.

MOBILE METAL ION EXTRACTION

Systematic and meaningful trends are shown after MMI extraction and analysis for a number of elements, including Cu, Au and Ag. The following graphs show the range of MMI values obtained for Cu, Au and Ag in overbank (SOS) samples.
Large variations in catchment outlet MMI Cu values are evident. Sites 201-210 have values above 1500 ppb Cu, over three times the "background" values of the lowest sites. The former sites are located to the north of Cobar (Figure 4) in catchments with known mineral occurrences. Site 128, which has nearly six times the values of lowest sites, is in the middle west, and Site 138 is within the Tibooburra catchment, which includes the Albert Goldfield, a gold camp with elevated values measured independently from lag and calcrite assays. A multiplicative index is a powerful discriminator where two (or more) elements associated with mineralization are sought as geochemical indicators, since the index will only be strong where both elements are well represented.

Figure 16 shows the multiplicative Au*Ag index for overbank outlet sites after MMI extraction and analysis.

Again there is considerable variation in values. Site 138, east of Tibooburra, again appears anomalous; this site is some 20 km east of the Albert Goldfield (elevated Au, Ag and Cu) where soils with MMI Au in excess of 100 ppb have been recorded within the same catchment. Sites 151 and 201 also have high Au*Ag (Figure 16) and are located north of Cobar in the vicinity of known Au, Ag, Cu occurrences.
CONCLUSIONS

1. A number of sites with anomalous catchment outlet sediment geochemistry are associated with catchments containing known outcropping mineral occurrences.
2. Not all catchments with known mineral occurrences have anomalous catchment outlet sediment geochemistry.
3. Partial extraction such as MMI analysis provides additional and distinct geochemical information to that provided by strong acid and XRF analysis. This may be due to an improved signal-to-noise ratio (MMI analysis) for what is effectively two-dimensional (surface) analysis versus three dimensional (bulk) methods.
4. Active alluvial sites are normally avoided in prospect scale MMI analysis; in this case active alluvium has been used to obtain distinctly “transported” information.
5. Very low density catchment outlet sediment sampling provides reliable representative geochemical information on a regional basis, with near-total and partial extraction data yielding complementary information.

REFERENCES


ACKNOWLEDGEMENTS

• Chief Executive Officer, Geoscience Australia
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Fig. 17. Transported MMI anomaly, Albert Goldfield