Temporal controls on gold anomaly formation in regolith: evidence from the east Wongatha area

by

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Of the 835 regolith samples from a regional regolith geochemical program carried out in the east Wongatha area (eastern Yilgarn Craton; Morris, 2011), 32 have anomalous Au concentrations (i.e. above 9 parts per billion (ppb) in the <50 µm fraction) following aqua regia digestion. These samples are spatially related to known or inferred bedrock-hosted mineralization. Analysis of Au in 50 of these samples following deionized water digestion showed a positive correlation with aqua regia data, suggesting that gold was fine grained and/or water soluble. Several sites from this program have been resampled to determine if the original Au results could be duplicated, if the fine fraction Au concentration changed with depth, and to collect stratigraphically controlled samples for dating. Data from one site (Sandpit locality) are discussed here.

Site location and sampling

The Sandpit locality is about 10 km east-northeast of the Energy and Minerals Australia exploration camp at Mulga Rock, on the Yilgarn Craton – Gunbarrel Basin margin. Mulga Rock is an unconformity-hosted uranium, gold, base metal and rare earth element (REE) deposit. In this area, extensive sandplain deposits are accompanied by longitudinal sand dunes up to four metres high, with regolith up to 55 m thick. During the regional sampling program, a sample from this locality (GSWA 200069) returned 14 ppb Au (lower level of detection (LLD) = 1 ppb) following aqua regia digestion. During follow-up work, a 1.8 m deep pit was excavated (Fig. 1), and stratigraphically controlled samples were collected for geochemical analysis and dating. Three samples were also collected for geochemistry from auger holes within a 20 m radius of the pit, using the same sampling methodology as the original program.

The sandplain is composed of pale yellow, moderately to poorly sorted, fine- to coarse-grained sand with less common silt and clay, similar to material found in the pit. However, fine-scale sedimentary structures are locally present in the pit, including low-angle cross bedding, and thin mud drapes on some bedding surfaces. Root casts and evidence of bioturbation are also found.

Geochemistry

Gold concentrations from the <50 µm fraction of the three surface samples collected at about 90 cm depth range from 11 to 14 ppb, consistent with the original result of 14 ppb. Samples from the pit range from 7 to 31 ppb Au, and show a gradual increase in concentration with depth. A pit sample collected at 15 cm depth has an Au content of 8 ppb, which is in the background range for the east Wongatha area. Gold determined in all samples following deionized water digestion (LLD = 0.05 ppb) shows a positive correlation with aqua regia data, implying that gold is either microparticulate and/or water soluble. In contrast to Au, other elements, such as Ca, Sr, Fe and As, show no consistent change in concentration with depth, indicating that gold is not controlled by either the carbonate content of regolith, ferruginization, or the presence of sulfides.

Dating

Three samples were collected from the pit for dating. Dating quartz-rich samples can be difficult, as they usually lack phases such as carbon or clay, which can be dated by

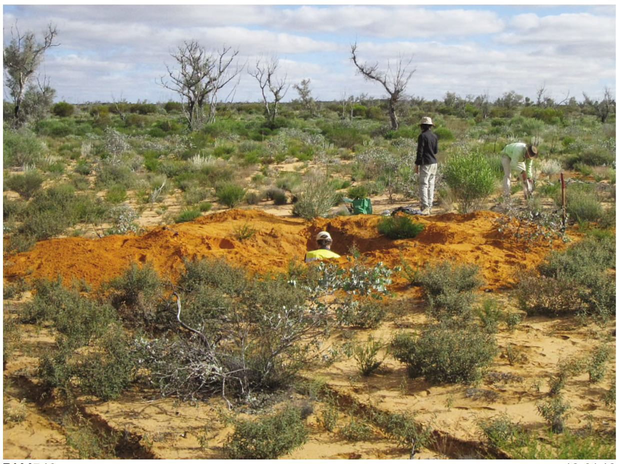

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Figure 1. **Pit excavation at the Sandpit locality, east Wongatha area (51J 584048E 6687480 N)**

conventional techniques such as ^{14}C or K–Ar. However, optically stimulated luminescence (OSL) is suited to such samples, as the quartz grains themselves can be directly dated by this technique. When quartz is exposed to sunlight, it is ‘bleached’; that is, any trapped radiation from the natural decay of radioisotopes is removed. On burial, electrons generated from naturally occurring radiation, as a result of radioactive decay, accumulate within the crystal structure in a regular fashion. These electrons can be released using an intense light source and the resulting measured luminescence is proportional to the time since the sample was last exposed to sunlight (Huntley et al., 1985).

The results of OSL dating of three samples from the Sandpit locality show a decrease in age from 90.9 ± 19.0 ka at 180 cm, to 38.9 ± 19.7 ka at 120 cm, to 6.7 ± 1.8 ka at 60 cm. Corresponding Au concentrations are approximately 31 ppb at 180 cm, 23 ppb at 120 cm, and 20 ppb at 60 cm. If Au is sourced from buried mineralization, the vertical change in concentration with decreasing age is about 1 ppb/7 600 years. The age data indicate that over the same time interval, about 11 cm of sand would have accumulated (average accumulation rate of 1 mm/70 years).

There are few recorded dates on sandplain (i.e. dune substrate), with most dates dealing with dune-forming events. OSL ages reported for the Sandpit locality span the ages recorded for eolian dunes summarized by Sheard et al. (2006) from Birdsville (36 ka), the Strzelecki Desert in South Australia (65 ka), and various localities in Victoria, Western Australia, and New South Wales (21, 36, 43 and 68 ka). Older dune-building ages of 115–135, 145–155, 185–205 and 225–235 ka have been reported from South Australia. Sheard et al. (2006) reported optical ages for six dune samples and one dune substrate sample from two sites in the Great Victoria Desert of western South Australia. The dune ages are older than those typically reported from elsewhere, apart from two younger ages of 71 and 22 ka. A single age for the dune substrate exceeded the limit of OSL dating at >250 ka.

Conclusions

Analysis of fine-fraction Au from a single locality in the east Wongatha area confirms that gold is both fine grained and extractable using weak leaches such as deionised water. Thus, gold is water soluble and/or microparticulate. Geochemical and geochronological data from stratigraphically controlled samples at one locality shows that the concentration of fine-fraction gold decreases with decreasing age and depth. These data indicate a vertical change in Au concentration of about 1 ppb/ 7 600 years, during which time about 11 cm of sand accumulated. Thus, the youngest sand deposits would have had insufficient time to accumulate a gold signature from buried mineralization, which has implications for mineral exploration in areas of thick and transported regolith.

References

Huntley, DJ, Godfrey-Smith, DI and Thewalt, MLW, 1985, Optical dating of sediments: Nature, v. 313, p. 105–107.

Morris, PA, 2011, Fine-fraction gold chemistry of regolith from the East Wongatha area, eastern Yilgarn Craton: Geological Survey of Western Australia, Record 2011/2, p. 24–26.

Sheard, MJ, Lintern, MJ, Prescott, JR and Huntley, DJ, 2006, Great Victoria Desert: new dates for South Australia’s oldest desert dune system: MESA Journal, v. 42, p. 15–26.