

Pete Williams introduced the next speaker for the evening, Glen Diemar, who presented the lecture '**Gold, Antimony and Tungsten Mines of Hillgrove**'. Glen had just presented to UWS earlier in the day a formal presentation of the thesis which he had completed for his Honours degree. He had kindly agreed to deliver a précis (presumably somewhat simplified and certainly much abbreviated) of his work.

Initially Glen explained that the full title of his Honours project was 'Supergene Geochemical Dispersion of Antimony and an exploration model for Antimony Ore Deposits'. He set out to examine the geochemistry of antimony in the oxide zone, above the water table. The outcome of the study has good implications for the mining industry in exploring for antimony ore deposits. In speaking about antimony and by way of an introduction the Glen showed a few slides of specimens of stibnite, the best of which in the world come from the Ichinokawa Mine on Shikoku Island in Japan, but which also come from a large number of other sites including Hillgrove in the New England region of NSW. A view was shown of a typical Hillgrove stibnite specimen which Straits Resources would be donating to the next sale of specimens in February for the Kids with Cancer charity.

The speaker then indicated with a few maps the location and topography of the Hillgrove mining area which is about 25 km to the east of Armidale before showing a large number of views of the countryside, mines, mining sites and mine workings. Hillgrove and the nearby township of Metz are about 2-3 km apart and situated on the east and west sides of the spectacular Bakers Creek Gorge which effectively bisects the area. Mineralisation and mines are scattered through the area with some shafts and workings on the high ground and some in the sides and bottom of the gorge which is about 600 meters deep and very steep in places. There are spectacular waterfalls in the area, particularly in the Oxley Wild Rivers National Park just to the east of the mining area. Some deposits in the Hillgrove field are still being worked and the main company is Straits Hillgrove Gold which helped fund Glen's studies.

Views were shown of the Eleanora mine, from which many collectors' specimens will have come. It was a multi-level mine with shafts descending from the top of the gorge and adits driven in from the sides and bottom. Hillgrove township is at a height of about 1,000 m above sea level and some of the Eleanora shafts were 600 m deep. Interestingly, one view was shown of an area towards the bottom of the gorge with electric power lines strung across with a row of coloured balls attached along the middle part of their length. This had been arranged because on occasion in the past pilots flying F111 jet aircraft from the Amberley airbase had practiced their low-flying ground-hugging flying skills by roaring up or down the gorge at very low altitude. The hope that the row of balls and the cable carrying them would be seen by the pilots or their terrain-following radar in time to avoid a collision when travelling at several hundred kph was probably a little optimistic!

Referring to the chemistry of minerals from the area Glen Diemar described a number of the primary and secondary species which are found. Stibnite oxidizes above the water table forming Sb^{3+} minerals which are not too stable in Nature and oxidize further to Sb^{5+} minerals. The relative solubilities, mobilities and the extent of dispersion of these minerals are questions that the speaker had answered in his thesis. Workers in the past had caused some confusion looking at antimony dispersion by using an artificial compound Sb_2O_5 as a proxy to model solubility studies. Sb_2O_5 is

not a natural mineral. A number of antimony secondary minerals was listed and described. Senarmontite and valentinite are dimorphous cubic and orthorhombic Sb_2O_3 oxides with fairly high solubilities. Brandholzite and bottinoite, $\text{Mg}(\text{Sb}(\text{OH})_2 \cdot 6\text{H}_2\text{O})$ and $\text{Ni}(\text{Sb}(\text{OH})_2 \cdot 6\text{H}_2\text{O})$, are geochemically less significant minerals due to their being even more soluble. However, aging of solutions containing Sb^{5+} gives the very insoluble species antimoninic acid, which is the basis of the stibiconite group with the pyrochlore structure. This is the key to why antimony is not easily dispersed in Nature. The solubility of the end-member stibiconite group mineral romeite is about 40 parts per billion Sb at room temperature, some five orders of magnitude less than the solubilities of brandholzite and bottinoite. The cubic pyrochlore species are the stable and dominant secondary minerals of antimony and all are very insoluble. This has considerable implications for geochemical exploration. Over the course of a number of visits to the Hillgrove mining area the speaker sampled seepage waters underground and analysed them for a suite of elements. His findings confirmed the very low antimony content of seepage waters in spite of the fact that water in some places had been flowing over surfaces of oxidising stibnite mineralisation up to 25 cm thick. The mineralogical and chemical evidence shows that antimony is not mobile in the supergene environment and are in accord with laboratory-based experimental studies.

Soil sample traverses across known mineralisation – the speaker established that the antimony content of soils only 50 meters from a lode falls to background values. This would mean that in conducting regional exploration for antimony ore deposits, antimony itself is not a good indicator since a prospecting team could easily miss a mineralised zone. A different pathfinder element such as lead or arsenic, which would disperse more easily should be looked for.

In conclusion Glen was pleased to note that the Straits Hillgrove Gold, who funded the field work of his project had already taken up the exploration strategy which he had established. In answering a number of questions the speaker was able to report that in spite of the present economic down-turn antimony was currently selling at about \$6,000 per tonne, Hillgrove being the sole producer of antimony in Australia. World production in 2006 was 130,000 tonnes with most of this being produced and used in China. Australian antimony goes mostly to Belgium and Japan. It is used among other purposes for fire-proofing of fabric materials such as children's clothing.

Glen has been awarded a First Class Honours degree at UWS and is currently working at Olympic Dam in South Australia.