Professor Robert Richard. Brooks: the godfather of hyperaccumulator plants, phytoremediation and phytomining.

Professor Robert Richard Brooks, passed away on 23 January 2001 after failing to recover from an infection following heart surgery last October. His work, still in full flight at Massey University and HortResearch, Palmerston North, New Zealand, revolved around the plants that he named 'hyperaccumultors'.

All plants extract metals from soils. However, a small minority extract massive quantities – far in excess of what is required for normal metabolic processes. An example of such a plant is *Sebertia acuminata* from New Caledonia. This is a forest-sized tree that bleeds bright blue sap when cut. The striking blue coloration comes from nickel citrate – the concentration of nickel in the dried sap is over 20%. There are over 400 species of known hyperaccumulator plants, the majority of which were discovered by Prof. Brooks and people he introduced to the subject. Of the 400 known hyperaccumulators, 300 accumulate nickel. The remainder accumulate such metals as zinc, cadmium, arsenic, thallium, manganese, cobalt and copper. New species are continuously being discovered.

During the last ten years, Prof. Brooks began work on inducing plants to take up other metals. His team's most well known success was inducing Indian mustard (*Brassica juncea*) to take up gold by adding a thiocynate compound to the soil.

Shortly after Prof. Brooks had documented his findings on hyperaccumulator plants, the scientific community started thinking of putting them to use. The plants had an obvious use in *biogeochemical prospecting* - the study of metal uptake patterns by plants as an indicator of underlying mineralisation. Robert Brooks had already been working on this technology using other species since 1966.

The next technology to emerge from Prof. Brooks findings on hyperaccumulators was the science of *phytoremediation*. Initially, phytoremediation was considered to be the use of hyperaccumulators to clean up heavy-metal contaminated soils. The modern definition is much broader including not only soils contaminated with heavy metals but also with organic contaminants, radionuclides and nitrates.

In the phytoremediation of heavy-metal contaminated soils, a 'crop' of hyperaccumulator plants is grown and the mature biomass removed and burned. The resulting ash may then be placed in a landfill (where it does not pose a risk to the environment) or smelted to recover the metal. The process is repeated until the soil metal-burden reaches acceptable levels.

Prof. Brooks also lead pioneering work on the use of plants to exploit commercially sub-economic ore bodies. This technology is known as "phytomining" metals such as nickel

can be smelted from hyperaccumulator plants and sold for a profit (see figure). The technology has applications in some developing countries such as Brazil, where farmers struggle to grow Soya beans on 'ultramafic' soils containing 0.2% nickel. Were the farmers to grow the nickel hyperaccumulator *Berkheya coddii* and harvest the nickel, a tenfold increase in profit could be realised.

Over his career, Robert published 290-refereed papers and nine books. Prof. Brooks's success stemmed from a personality that had even greater depth than the science he practised. He was an excellent communicator, being able to converse fluently in English, French, German, Russian and Swahili and had a good working knowledge of Portuguese, Spanish and Chinese. Extensive collaborations with overseas investigators were usually carried out in their native language. He oozed enthusiasm and optimism and ported a wicked sense of humour. Underpinning these qualities, Prof. Brooks had great integrity, often letting others take the limelight for work that he initiated.

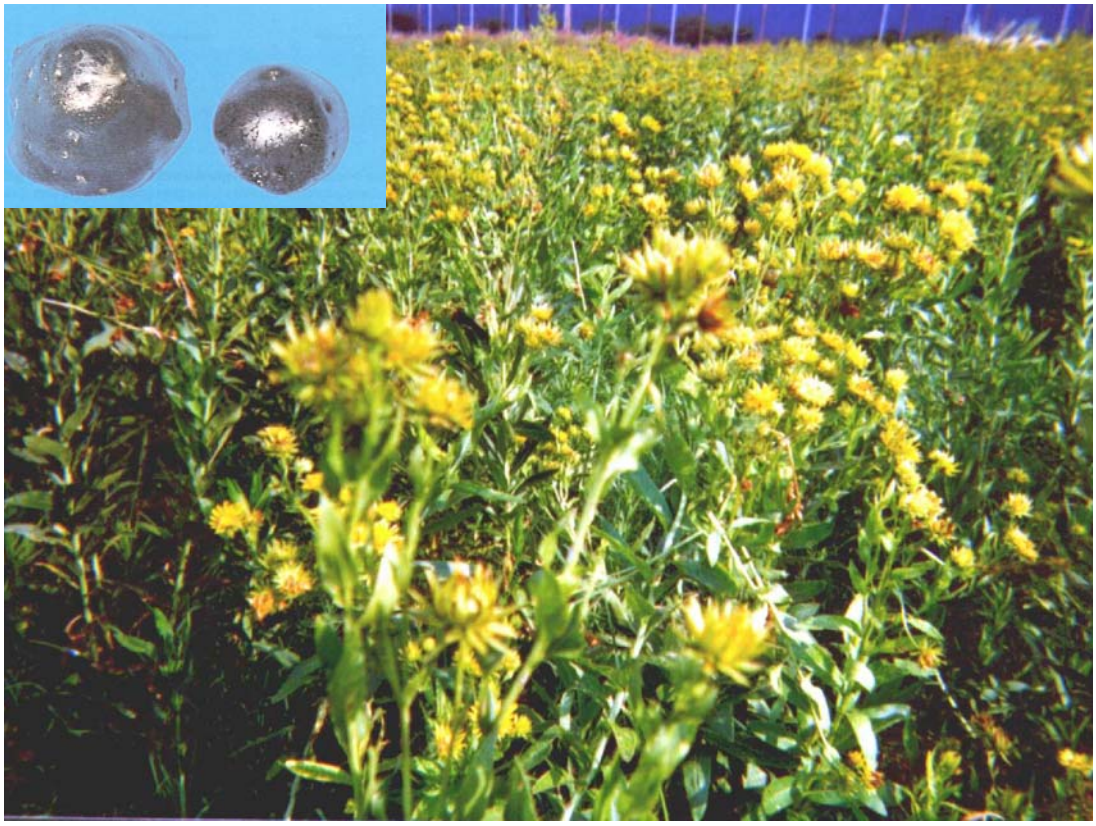

Figure. A field of the nickel hyperaccumulator *Berkheya coddii.* The biomass production is 22t per hectare per annum, with an average nickel concentration of 1% on a dry matter basis. In the top left hand corner are buttons of nickel that have been smelted from this plant.