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PLATINUM-GROUP ELEMENTS – FROM GENESIS TO BENEFICIATION AND ENVIRONMENTAL IMPACT

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Every four years, geologists from academia, national geological surveys, exploration and mining companies, interested in the platinum group elements (PGE) hold an international symposium to discuss the latest geological ideas, exploration targets and technical information. However, only three years separated the 9th meeting held near the Stillwater Complex in Montana, U.S.A. (1), and the 10th meeting held in August 2005 in Oulu, Finland (2), perhaps reflecting the interest in these commodities. The main organisers of the meeting were Tuomo Alapieti (University of Oulu) and Markku Iljana (Geological Survey of Finland). As Finland and western Russia have been centres of intense exploration for platinum during the last few years, Oulu was an interesting locale for the meeting.

As always, there was a variety of presentations (totalling over 200) covering discoveries and evaluations of mineralised areas, descriptions of the host rocks (usually layered igneous intrusions), characterisations of different platinum-group mineral assemblages, and ideas on the processes that induce platinum mineralisation.

What is new are the changes in reporting on exploration programmes to stock exchanges. This has meant that much more quantitative information is available about PGE developments than ever before. Unlike previous Platinum Symposia, exploration companies are now keener to report their results, and give ore body models. Many interesting areas were described, but none that is going to change the future of PGE mining (3).

The Baltic Shield

Starting in Finland and Russia (geologically called the Baltic Shield), many ancient intrusions carry some PGEs and copper-nickel (Cu + Ni) sulfides. Important resources occur in the Portimo Complex (over 200 Mt at 2 g t^{-1} Pd + Pt + Au), Koillismaa, Penikat and Keivitsa Complexes. Despite drawbacks of variable grade and lack of local smelter, North American Palladium is interested in continuing exploration in these areas. Many other intrusions have been incompletely evaluated.

The Burakovka intrusion lies in western Russia, and at 720 km^2 is the largest in Europe. Good mineralisation occurs in a chromitite layer (like the UG2 in the Bushveld Complex) and at other levels in the igneous intrusion. Another large, but deformed intrusion, the Monchegorsk intrusion (550 km^2), contained a high-grade, vein-like Ni-Cu sulfide-rich system, largely mined out, but now has been found to host two PGE-enriched layers with significant tonnage, although continuity of grade remains to be demonstrated. The Fedorova-Pana intrusion has a strike length of 40 km and thickness of 3.5 km. A thick mineralised zone up to 50 m wide, allegedly like the J-M Reef of the Stillwater Complex, has been traced for 1.4 km. Grades are quoted at 2–10 g and up to 0.5% Cu + Ni, but resource tonnages were not given.

Unlike these layered examples, the Keivitsa body is a massive ultramafic plug, 3 by 4 km, with a central ore body of 1 km^2, extending to at least 500 m depth. It has a resource of 315 Mt at 0.5% Cu + Ni and 0.2 g t^{-1} PGE.

Canadian Occurrences

A jump to describing occurrences in Canada may seem a long way, but geological evidence was presented that Fennoscandia (Baltic Shield) and Ontario/Quebec (geologically called the Superior Province) were once joined before very ancient continental drift separated them over 2 billion years ago. Many small layered intrusions in that part of Canada may be part of the same igneous event as those just described. Examples, such as the River Valley intrusion (25 Mt at 1.4 g t^{-1} Pd + Pt + Au) and the Shakespeare intrusion with a 14 km strike length and 7 Mt at 0.8% Cu + Ni and 1g t^{-1}

PGE were documented. While such tonnages may not seem large, the occurrences are near Sudbury, and may be able to take advantage of the proximity to Sudbury's mining and smelting infrastructure.

Exploration in Sudbury was (to our minds) the most important in terms of significant and probable further ore exploitation. Despite its geographic location, it is 600 m years younger than the previously described occurrences in the Baltic/Superior supercontinent. The deeper, distal, Cu-rich sulfides, with relatively higher PGE, have been known for a long time, but exploration programmes seem to be getting better at finding their targets, and a number were described (for example, McCreedy West and Podolksy). Tonnages were not given, but grades of up to 10 g t^{-1} were common. A smaller high-grade occurrence on the east rim has 13 Mt at 5% Cu + Ni and 4 g t^{-1} PGE. Particularly interesting are aureoles of low-sulfide but high-PGE mineralisation that have not been fully appreciated until recently. They have been recognised around some of the distal, sulfide-rich zones, and may exist around many more.

The Duluth Complex, on the shore of Lake Superior, has been extensively explored. It has a marginal zone that is sparsely mineralised. It has enormous but low-grade Cu, Ni and PGE deposits. Extraction by leaching of the metals is being developed, and is considered viable.

New Discoveries

A Ni-Cu-PGE discovery was reported from Western Australia. The Nebo and Babel intrusions are mafic rather than ultramafic and have a thick mineralised layer near their centre. Tonnages and grades are: 400 Mt, 0.6% Cu + Ni and 0.2 g t^{-1} PGE. Somewhat similar is the remote Ferguson Lake deposit in Canada. A deformed gabbroic sheet, 14 km long by 500 m thick has a sulfide-rich zone, 60 Mt at 1% Cu+Ni and 1.5 g t^{-1} PGE. A lower unit, poorer in sulfides, but richer in PGE, has recently been identified.

Brazil

A Brazilian intrusion, Serra da Onca, was described. It is extensive (25 km), with an ultramafic lower half and gabbroic upper half, like the Bushveld Complex. Near and above the boundary is a thick zone (200 m) with elevated PGE values, but generally not exceeding 1 g t^{-1}.

Summaries

New PGE information from the traditional areas: Bushveld, Noril'sk, Great Dyke and Stillwater, was sparse, except for the Platreef, about which one compilation suggested resources of 600 Mt with grades from 1 to 2.5 g t^{-1}. In terms of this tonnage, all the other occurrences mentioned above are dwarfed into insignificance. In all recent reports of explorations, base metals have become an important component of any possible resource estimate, and it is anticipated that in the future exploitation will depend upon both precious- and base-metal extraction. Perhaps one general important observation about all these occurrences is that palladium exceeds platinum.

References

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2 http://platinumsymposium.oulu.fi/
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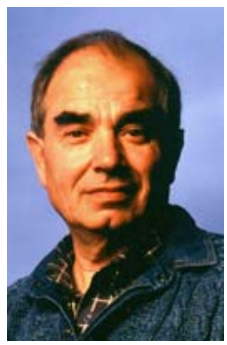
The Authors

Grant Cawthorn was born in England. He has geology degrees from Durham and Edinburgh Universities. After a post-doctoral fellowship in Newfoundland, he now teaches igneous petrology in the School of Geosciences at the University of the Witwatersrand, South Africa. His main interests lie in the formation and vast reserves (Pt, Cr, V) of the Bushveld Complex. His University post is supported by the mining industry, and he holds the title of the Platinum Industry's Professor of Igneous Petrology.



Tony Naldrett emigrated to Canada from the U.K. in 1957. In 1967 he joined the Department of Geology, University of Toronto, retiring in 1998. He is a Professor Emeritus, continuing to research magmatic sulfide deposits. His most recent book is "Magmatic Sulfide Deposits: Geology, Geochemistry and Exploration", Springer-Verlag, 2004. In 2002 the Society of Economic Geologists awarded him the Penrose Gold Medal. He is currently an Honorary Professor in the School of Geosciences, University of the Witwatersrand.