Industry-Academic Alliance Maps Lithosphere of the Slave Craton, NWT, Canada

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Kimberlite eruptions sample many lithologies during ascent, starting from a point deep in the lithosphere and traversing hundreds of kilometers to surface. Peridotite and eclogite xenoliths and single mineral xenocrysts (including diamond) are carried to surface with the eruption. When kimberlites are discovered, drill core is submitted to diamond exploration laboratories to recover heavy mineral concentrates for chemistry, and microdiamonds for statistics. Mantle xenoliths may also be found while logging core. Exploration companies use these data to determine the quality of a kimberlite discovery. When positive economic potential is determined, exploration will continue though bulk sampling, and advance to development. As development advances, a new team focussed on engineering and mining replaces the exploration team.

Exploration geologists, during the transition to mining, usually move on to another project. Mantle samples that were carefully collected during core logging, are left in storage rooms at the project site or head office. Later, someone unaware of the importance of the samples discards the specimens to make room for another filing cabinet.

Meanwhile, in a distant university, a researcher struggles with too little data, trying to resolve the nature of the mantle. Oh, if there were only decent samples…

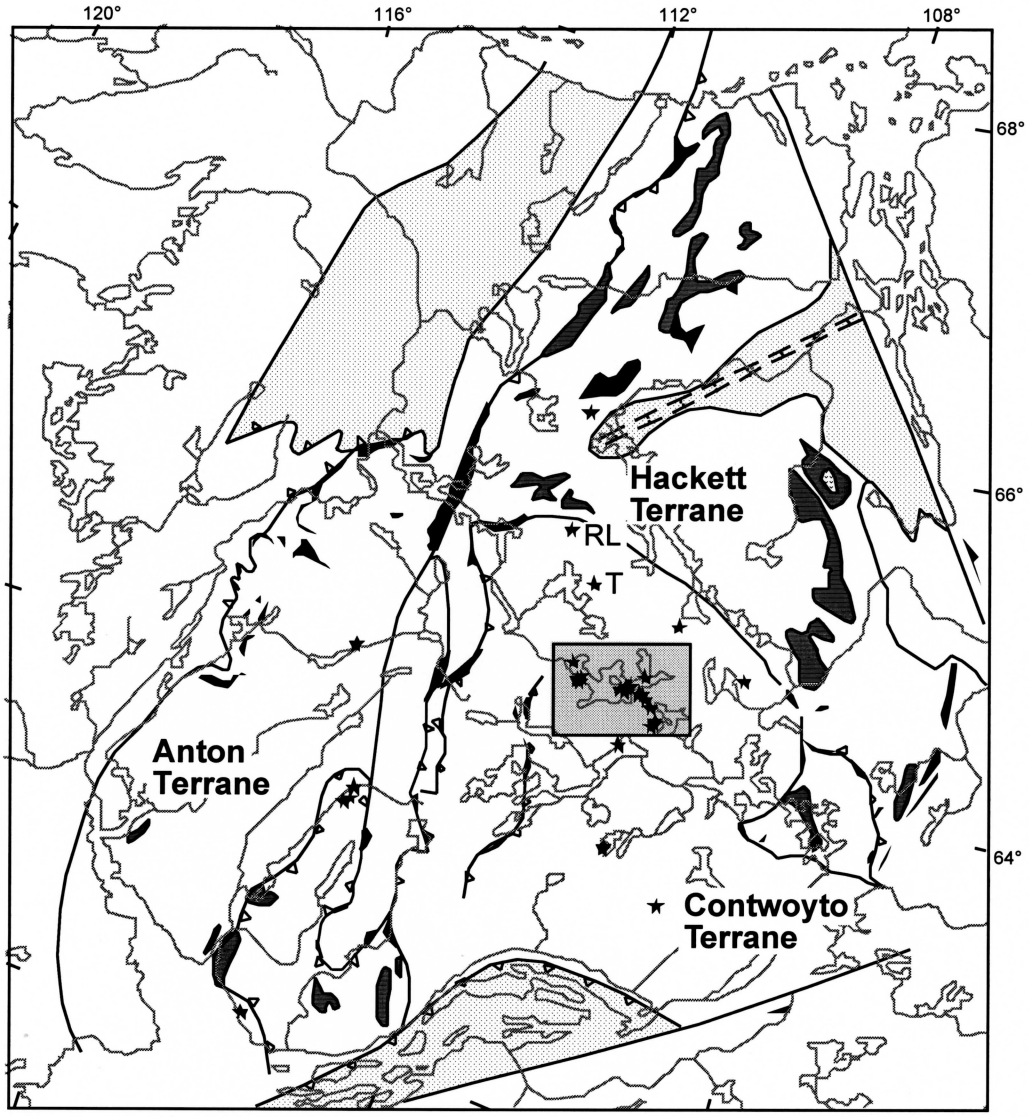
This is an all too common story.

Mantle samples are very rare specimens, in fact so rare that there was once talk about registering each one. Since access to kimberlite core is limited, exploration geologists must participate in research by getting mantle samples into universities, accompanied by locations and pipe names. Researchers can identify and perpetuate a sample's importance in scientific literature for everyone's benefit. Explorers will, in turn, learn more about their discoveries because they will find themselves participating in research, rather than just reading it.

Dialogue between academic and industry geologists will improve everyone's understanding of geology and corporate and university issues. Industry must keep sensitive information confidential and universities must publish. The two groups seem in opposition, but each group's issues can be addressed in several ways. Confidentiality agreements, review of documents before publication, or reasonable delays (1 year) in publishing data will allow companies to act on outcomes of research that improve their ability to focus exploration on the most promising areas. Site visits by researchers are the best way to get dialogue flowing.

Ongoing mineralogical and geochemical work by Kennecott Canada Exploration Inc, R.L. Barnett Geological Consulting Inc and GEMOC (Key Centre for Geochemical

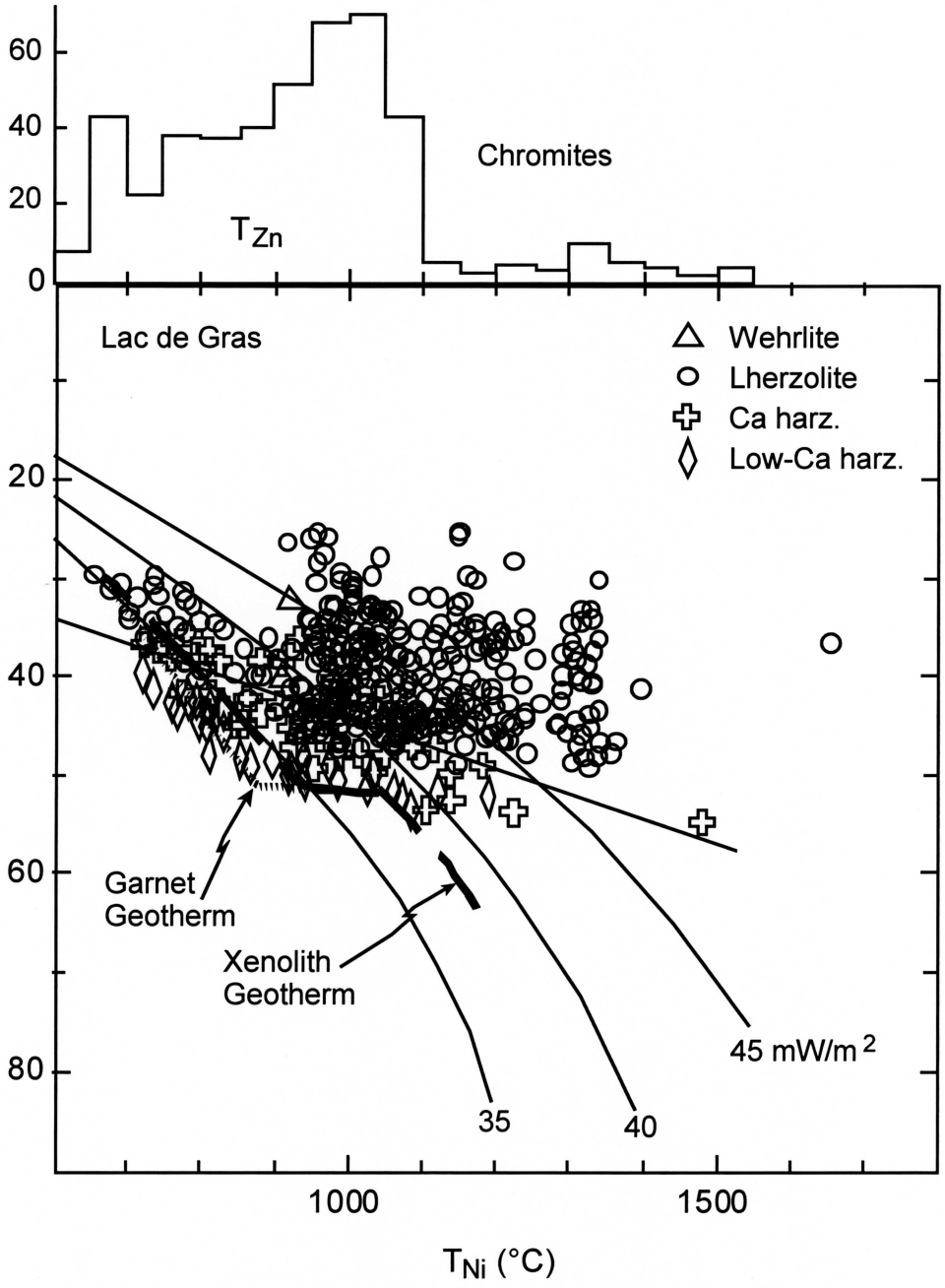
Evolution and Metallogeny of Continents), Macquarie University is an example of a strong industry-academic alliance. Other companies like Diavik Diamond Mines Inc, Aber Resources Ltd, Kretschmar Geoscience, and Ashton Mining of Canada are also key participants in this work with their donation of samples, data and ideas. Compilation of this wide-reaching data set has improved understanding of the nature of the lithosphere beneath the Slave Craton and created the first geological map of the Slave lithosphere.



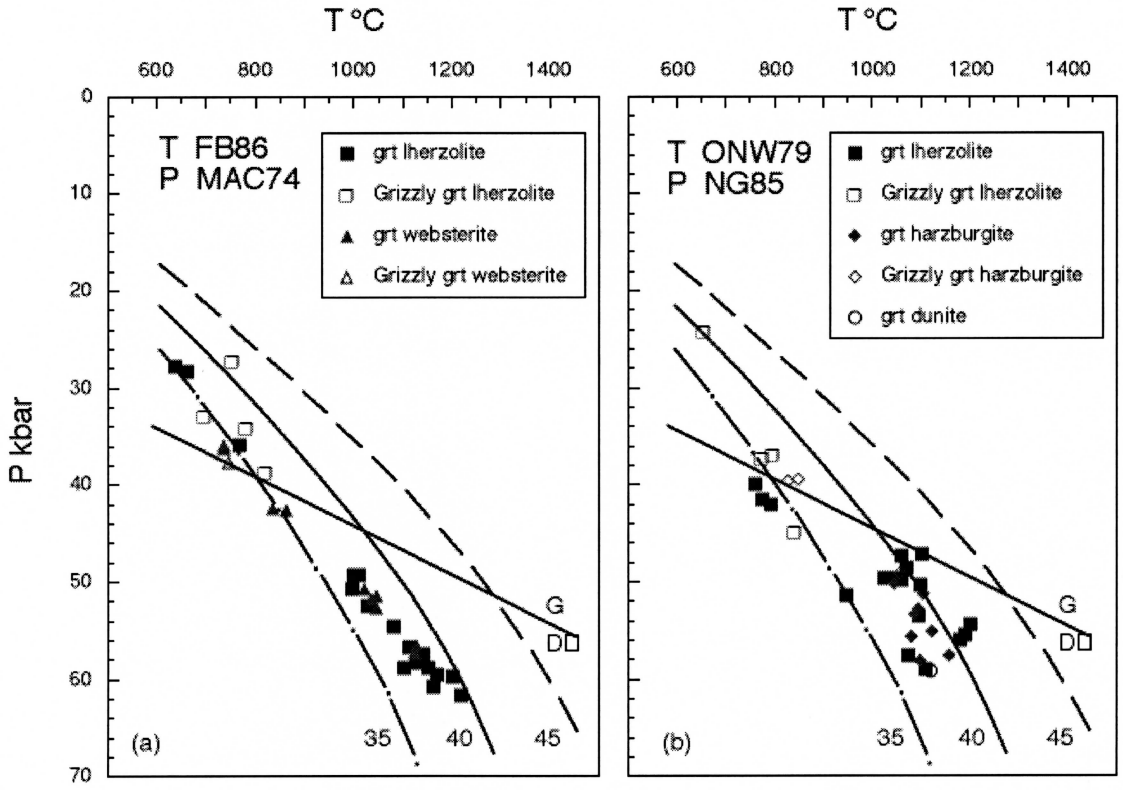
Lithospheric Mapping Tools:

Geochemistry of heavy-mineral concentrates (garnets, chromites), xenoliths, and diamond inclusions have been used to determine the composition, structure and thermal state of lithospheric mantle beneath the Slave Craton. Regional compilation of data is used to map the lithosphere laterally and with depth. Heavy mineral concentrates from kimberlite and overburden samples provide a suite of mantle derived minerals that can be used to study the lithosphere. Collection of mineral suites is conducted in a way to assure

that the full chemical range of each kimberlite/anomaly is sampled. This assures that important lithologies sampled by the kimberlite are not missed. Garnets are analysed for nickel temperature (T_{Ni}), and chromites for zinc temperature (T_{Zn}), which place the grains in context at depth. Paleogeotherms derived from Lac De Gras concentrates are close to a 35 mW/m2 conductive model at T< 900(C, and a 38mW/m2 model above this temperature. A two-layer structure is implied. The upper layer (<145km.) is ultradepleted in Y, Zr, Ti, and Ga. The lower layer (to >200km.) is more similar to Archean mantle worldwide, and is dominated by more fertile lherzolite, which may have been underplated on depleted mantle by a plume head rising from the deep (Griffin et al., 1998).



Xenoliths collected during core logging are forwarded Kennecott's lab, where collection of a full suite of xenoliths varieties is completed. Petrology, oxide and trace element chemistry is completed, then P/T calculations are used to place each xenolith in the mantle stratigraphy. Robust P/T calculations are possible with xenolith data because coexisting minerals provide pressures and temperatures that overlap and support one another. Xenolith research confirms the stepped geotherm evident from garnet-chromite data provided by heavy mineral concentrates. Eclogite xenoliths provide temperatures useful in understanding the distribution of this important rock type in the lithosphere. The temperature range present suggests that eclogitic rocks are dispersed throughout the stratigraphy of the Slave lithosphere.



Diamond inclusion studies by GEMOC provide preliminary insight about diamond paragenesis in the Slave. From a small sample of diamonds from kimberlite DO27, paragenesis of diamond is suggested at 50% eclogitic, 25% peridotitic and 25% super-deep origin. This distribution provides clear evidence that peridotitic indicators (such as G10 garnets) may not necessarily be the best indicator of diamond potential in Slave kimberlites. This knowledge improves geochemical interpretation of overburden anomalies and kimberlites, and helps geologists focus exploration dollars on the most prospective targets.

Paleogeotherms can be established in any terrain with peridotitic indicator minerals (garnet and chromite). The accuracy of a heavy mineral concentrate geotherm is established from xenolith data, which allows more robust P/T calculations by using

geochemistry of coexisting minerals. Diamond inclusion work then provides a layer of important information to help understand the source rocks of diamond in the mantle.

Regional variability in mantle geochemistry and geology is evident in the Slave, and therefore it is important to continue research and further define the mantle map. Exploration companies have much to gain from continued participation in this research.

ACKNOWLEDGEMENTS:

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