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KIMBERLITE INDICATOR MINERALS IN TERRIGENE SEDIMENTS OF LOWER PART OF MACKENZIE RIVER BASIN, NWT, CANADA: EVIDENCE OF NEW CRATON WITH THICK LITHOSPHERE

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Introduction

Over 200 kimberlite bodies were discovered inside the Slave craton beginning from 1991 till now (e.i. Stabley, 2004), and it was the custom that there is not any Archaen craton to West – Northwest from the Slave craton. But there are some robust data suggesting the presence of another Archaen craton situated in lower part of Mackenzie River containing diamondiferous kimberlites: 1. It is difficult to connect numerous (many tens) finds of diamond crystals in alluvial sediments of the Yukon River Basin with the diamondiferous kimberlites of the Slave craton: these finds were situated in a great distance away from the known diamond sources inside the Slave craton (over 1,000 km). 2. Laurentide Ice (~18,000 ybp) can't to transport products of kimberlite erosion so far first, and second, the reconstruction of the ice movement shows that the Slave craton kimberlite material can be transported by ice to N-NW but the way of its movement was situated about 250 km to East from the Great Bear Lake. 3. Structural and magnetic field features of this area are similar to those typical for Archaen cratons. 4. Pre-Laurentide Ice Late Paleocene to Pliocene river systems of this area transported eroded material in NE and E directions, so pre-ice rivers can't to deliver material from the Slave kimberlites to areas situated to West from the Great Bear Lake. 5. There are known some kimberlites in the marginal parts of the area: the Darnley Bay cluster (NE margin, 7 pipes of Permian age of emplacement) and the Mountain Diatrema (S-SW margin). Information mentioned above and some additional data were taken by N.P. Pokhilenko in 2000-2001 into account, and he created a forecast about the presence of Archaen craton which contains diamondiferous kimberlites in the northwestern part of the North American Interior Platform (Lower part of Mackenzie River basin). This forecast initiated a diamond exploration program in this area.

Methods

Alluvial sediments and some terrigene secondary collectors of large area (~150,000 km²) to N, NW from the Slave craton and to W from Great Bear Lake were sampled for kimberlite indicator minerals (KIM) during the diamond exploration program (field seasons of 2002-2006) arranged by Diamondex Resources Ltd., Canada. Cr-pyropes, magnesian ilmenites and chromites were found in many hundreds of samples, and over 30,000 of KIM grains from these samples were studied and analyzed using optical microscopes, SEM LEO1430VP, the JEOL Super Probe 7800 and CAMECA Camebax Micro microprobes at Analytical Center of Sobolev Institute of Geology and Mineralogy of Siberian Branch of Russian Academy of Sciences, Novosibirsk, Russia.

Results

A comparative analysis of composition peculiarities of the studied KIM from the sampled area showed that:

- 1) there is variable but high proportion of Cr-rich varieties of pyropes (>7 wt.% of Cr₂O₃, Fig. 1) among the most of pyrope bearing samples and several tens of samples contain high-Cr subcalcic knorringite-rich (Mg₃Cr₂Si₃O₁₂ up to 30 mol. %), and in some of these samples together with G10 garnets were found diamond crystals of kimberlitic morphological types;
- 2) chromites also have all the compositional features typical for kimberlite chromites (Cr₂O₃ – 15-65 wt.%; MgO – 9.8 – 28.9 wt.%; TiO₂ – 0.01-8.5 wt.%, Fig. 2).
- 3) magnesian ilmenites have all the compositional features of typical kimberlite ilmenites (MgO – 6-15 wt.%; Cr₂O₃ – 0.1-9.5 wt. %; hematite - Fe₂O₃ – 3-28 mol.%; Fig. 3); KIM were found both in samples taken in modern alluvial deposits of many hundreds of rivers of sampled area and in samples taken from terrigene secondary collectors of the

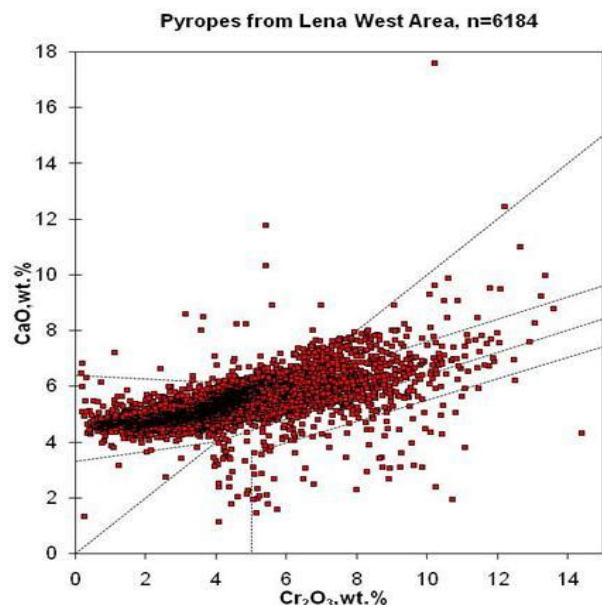


Fig. 1. Cr_2O_3 vs CaO plot for pyrope garnets from terrigene sediments of the northwestern part of the Interior Platform.

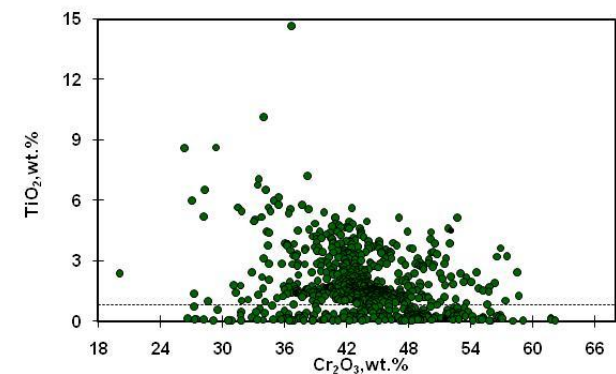
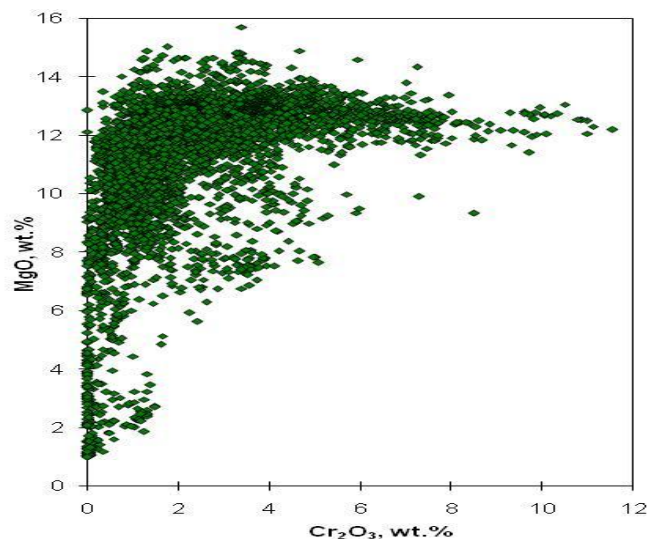
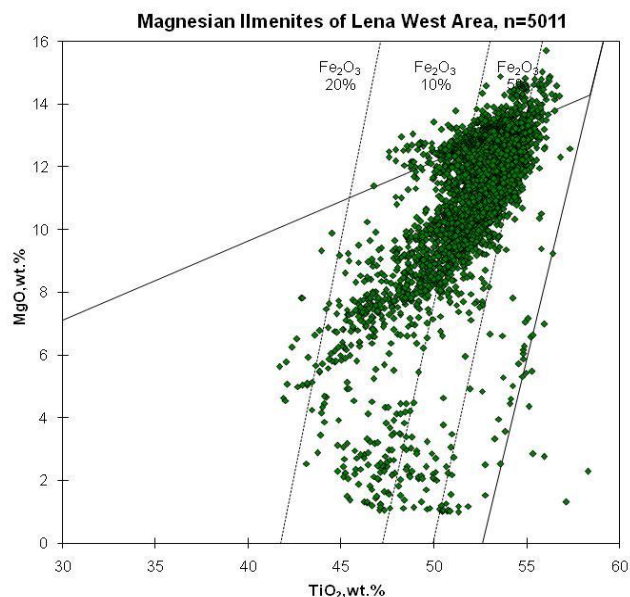


Fig. 2. Cr_2O_3 vs Al_2O_3 and Cr_2O_3 vs TiO_2 plots for chromites from terrigene sediments of the northwestern part of the Interior Platform (samples of Blue Fish River basin).

Fig. 3. TiO_2 vs MgO and Cr_2O_3 vs MgO plots for magnesian ilmenites from terrigene sediments of the northwestern part of the Interior Platform.

basal horizons of Mesozoic ages. Very high concentration of KIM was found in the secondary collector of Cretaceous age composed by terrigene sediments of basal horizon underlying by Middle Paleozoic sedimentary rocks on the Blue Fish River right slope, situated in SE part of studied area. These KIM grains have wide range of grain sizes (unsorted in size; range 0.1 – 6.0 mm); they have very low level of mechanical wearing, and they belong definitely to the continental type of KIM halos. Kimberlite type zircons from the Blue Fish River secondary collector KIM suite showed Low Jurassic age of emplacement of their matrix



kimberlite, and some of analyzed metamorphic zircons showed Archean U-Pb ages (Agashev et al., 2008).

Discussion

A wide distribution of KIMs and numerous finds of diamond crystals inside large territory (~150,000 km²) in the NW part of the Interior Platform together with geological data such as reconstruction of water movement in the pre-ice regional river system, peculiarities of Laurentide Ice movement, structural and geophysical features of the area allow us to suppose a presence of the Archaean craton in studied area. Presence of KIMs in the secondary collectors of Mesozoic age is a good evidence of the local origin of their kimberlite primary sources. Another important result is finds of KIMs including high-Cr cubcalcic G10 garnets in alluvial sediments of small tributaries of Klondike River draining some secondary collectors of the Late Mesozoic age developed in the area close to cites of diamond crystals finds reported by gold prospectors previously.

Conclusion

So, all the obtained data both mineralogical and geological indicate that it is very likely that there is another ancient craton inside the northwestern part of the Interior Platform, NWT, Canada, situated to W-NW from the Slave craton. This new craton has a size close to one of the Slave craton, and it is covered by Paleozoic and Mesozoic platform type sediments widely developed in lower part of Mackenzie River basin. A presence of diamonds and high pressure varieties of KIM (high-Cr subcalcic pyropes and high-Cr chromites) is a robust and reliable evidence of existence of a thick lithosphere (> 200 km) of this craton and presence inside it multiple kimberlite bodies including diamond-bearing ones (e.i. Sobolev et al., 1993; Pokhilenko, Sobolev, 1995; Pokhilenko et al., 1999; Grutter et al., 2004).

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