Geochemical characteristics of Antarctic magmatism connected with Karoo-Maud and Kerguelen mantle plumes

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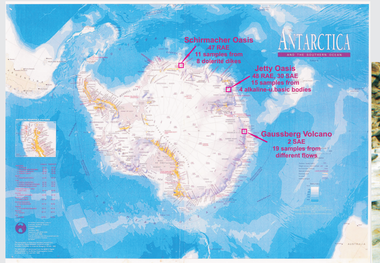
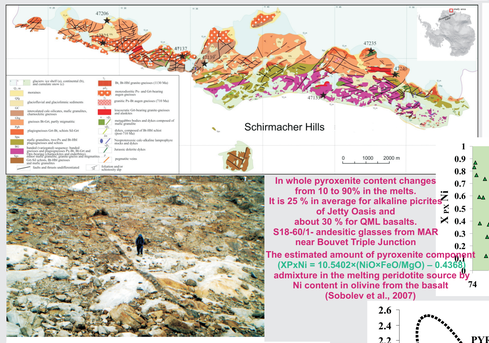
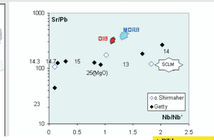
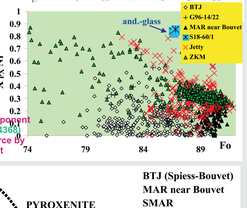
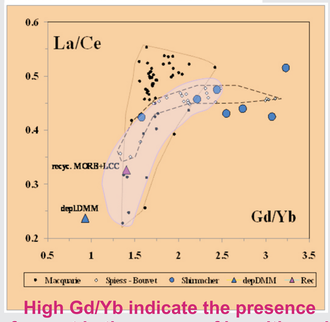




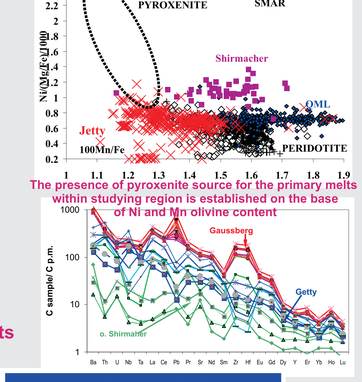


In whole pyroxenite content changes from 10 to 90% in the melts.
It is 25 % in average for alkaline picrites of Jetty Oasis and about 30 % for QML basalts.
S18-60/1- andesitic glasses from MAR near Bouvet Triple Junction
The estimated amount of pyroxenite component (XPxNi = 10.5402×(NiO×FeO/MgO) – 0.4363) admixture in the melting peridotite source by Ni content in olivine from the basalt (Sobolev et al., 2007)

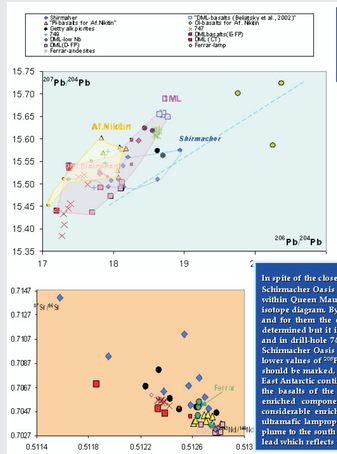




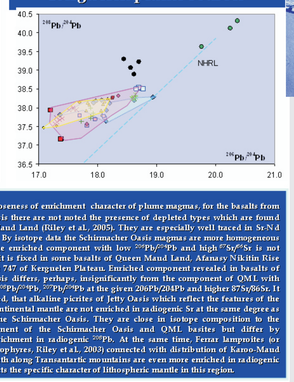
High Gd/Yb indicate the presence of garnet in the source of basaltic melts of the Shirmacher region



The presence of pyroxenite source in the primary melts within studying region is established on the base of Ni and Mn olivine content

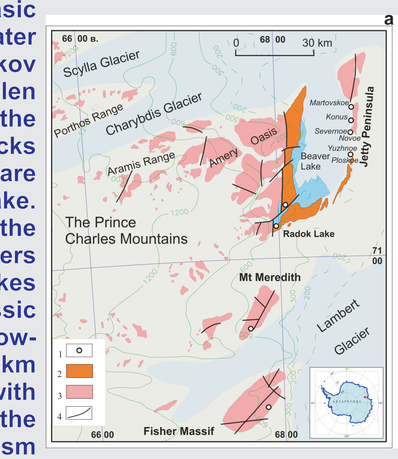


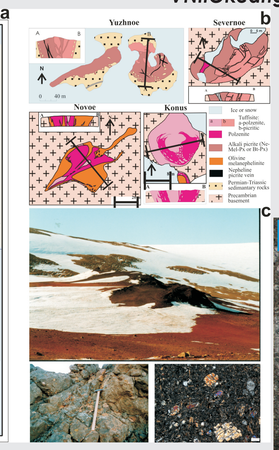
Variations Pb, Sr, and Nd isotopic characteristics for the DML and Kerguelen plume sources

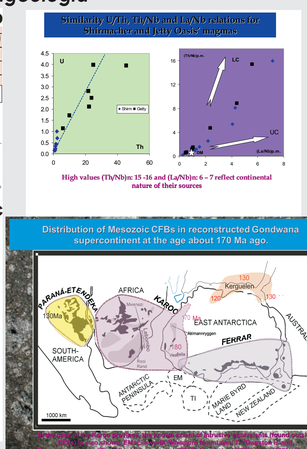


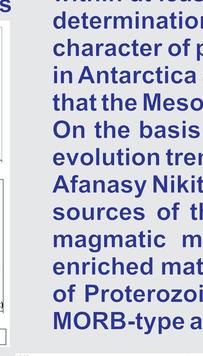
In spite of the closeness of enrichment character of plume magmas, for the basalts from Schirmacher Oasis there are not noted the presence of depleted types which are found within Queen Maud Land (Riley et al. 2005). They are especially well traced in Sr-Nd isotope diagram. By isotope data the Schirmacher Oasis magmas are more homogeneous and for them the enriched component with low $^{208}Pb/^{204}Pb$ and high $^{87}Sr/^{86}Sr$ is not determined but it is fixed in some basalts of Queen Maud Land, Afanasy Nikitin Rise and in drill-hole 747 of Kerguelen Plateau. Enriched component revealed in basalts of Schirmacher Oasis differ, perhaps, insignificantly from the component of QML with lower values of $^{208}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$ at the given $^{206}Pb/^{204}Pb$ and higher $^{87}Sr/^{86}Sr$. It should be marked, that alkaline picrites of Jetty Oasis which reflect the features of the East Antarctic continental mantle are not enriched in radiogenic Sr at the same degree as the basalts of the Schirmacher Oasis. They are close in isotope composition to the enriched component of the Schirmacher Oasis and QML basites but differ by considerable enrichment in radiogenic ^{208}Pb. At the same time, Ferrar lamprоites for ultramafic lamprophyres Riley et al. 2003) connected with distribution of Karoo-Maud plume to the south along Transantartic mountains are even more enriched in radiogenic lead which reflects the specific character of lithospheric mantle in this region.

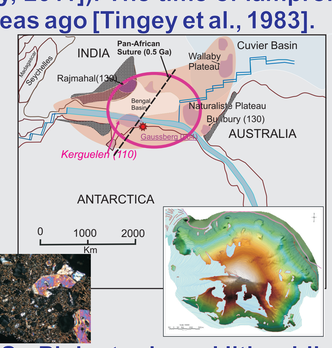
Emplacement (130-115 m.y. ago) of dikes and sills of alkaline-ultrabasic composition within Jetty oasis (East Antarctica) is suggested as a later appearance of plume magmatism within the East-Antarctic Shield [Andronikov et al., 1993, 2001; Laiba et al., 1987]. This region is located opposite Kerguelen Islands and possibly could be properly connected with activity of the Kerguelen-plume [Foley et al., 2001, 2006]. Jurassic-Cretaceous dykes, stocks and sills of alkaline-ultrabasic rocks, relatively close to kimberlite-type, are exposed within Jetty oasis and on the southern shore of the Raddock Lake. This alkaline-ultrabasic magmatism has appeared to be connected with the main Mesozoic stage of the evolution of the Lambert and Amery glaciers riftogenic structure [Kurinin et al., 1980, 1988]. The alkaline-ultrabasic dikes and sills within Jetty oasis cut the rocks of the Beaver complex, Permo-Triassic terrigeneous successions of the Amery complex, and late Paleozoic low-alkaline basic dikes as well. Dashed chain of 6 stock bodies spread out on 15 km along the eastern shore of the Beaver Lake, marked their allocation with submeridianal zone of the deep cracks, boarded of the eastern side of the Beaver Lake trough. At the same time, new data upon Quaternary magmatism of the mountain Gaussberg has confirmed the unique features of ultra-potassium alkaline magmatism (up to 14-17% K2O) formed under exclusively continental conditions [Murphy et al., 2002]. Volcanic cone is located at the continuation of Gaussberg rift zone which is possibly a part of Lambert fracture zone. Its formation is connected with the early stages of Gondwana development, perhaps, reactivated in different Precambrian events and according to numerous data is a single rift zone which is traced Indian inland (Indrani graben, [Golynsky, 2011]). The time of lamproitic magmas eruption is estimated at 56000±5000 yeas ago [Tingey et al., 1983].

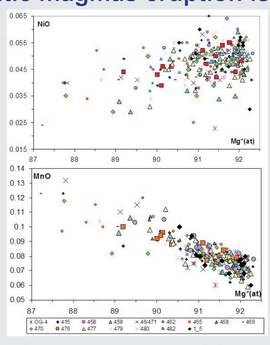


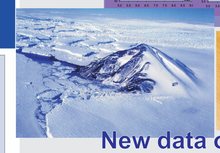


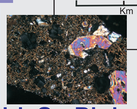




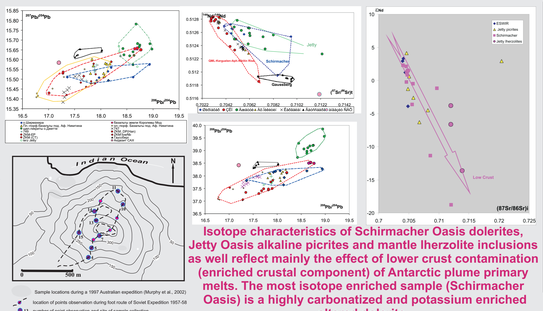




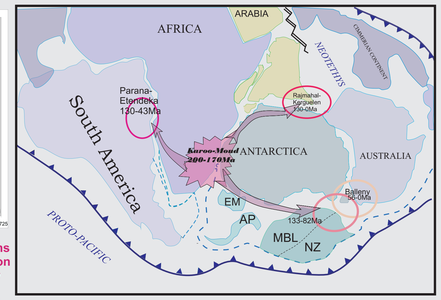




New data obtained on Nd, Sr, Pb isotopic and lithophile element compositions of the alkaline-ultrabasic rocks from the Jetty oasis and Gaussberg volcano give additional constraints on the last stages of the Kerguelen-plume evolution within Antarctica. It has been confirmed the unique character of enrichment for Gaussberg volcano alkaline lamproiites. Highly radiogenic Sr and Pb isotope ratios of these lamproiites reflect melting of the ancient sublithospheric depleted mantle that was stored from the Archean till nowadays unaffected by metasomatic-enrichment processes. It has been suggested some additional input of substances (crustal fluid of sediment origins, subducted sediments etc.) with high Rb/Sr ratio during the later mantle melting.



Isotope characteristics of Schirmacher Oasis dolerites, Jetty Oasis alkaline picrites and mantle lherzolite inclusions as well reflect mainly the effect of lower crust contamination (enriched crustal component) of Antarctic plume primary melts. The most isotope enriched sample (Schirmacher Oasis) is a highly carbonatized and potassium enriched altered dolerite.



It has been shown previously the Mesozoic (about 170 Ma) basaltic dykes of the Schirmacher Oasis and basalts and dolerites of the Queen Maud Land (180 Ma) are identical in petrology and geochemistry terms and supposedly can be interpreted as the manifestation of the Karoo–Maud plume activity in Antarctica [Sushchevskaya et al., 2012]. The spatial distribution of the dikes indicates the eastward spreading of the plume material from DML to the Schirmacher Oasis within at least 10 Ma (up to ~35 Ma, taking into account the uncertainty of age determination). On the other hand, the considerable duration and multistage character of plume magmatism related to the activity of the Karoo–Maud plume in Antarctica and Africa [Leat et al., 2007; Luttinen et al., 2002] probably indicate that the Mesozoic dikes correspond to a single stage of plume magmatism.

On the basis of obtained isotopic data it has been determined two magmatic evolution trends for basalts from: Queen Maud Land – Kerguelen Archipelago – Afanasy Nikitin Rise (Indian Ocean) and Jetty – Schirmacher oasises the mantle sources of those are quite different. Thus the Jetty – Schirmacher oasises magmatic melt sources are characterized by prevalence of moderately enriched matter or primitive chondritic mantle source and lithospheric mantle of Proterozoic ages but the substances of depleted mantle source similar to MORB-type and ancient mantle are absent.