

$^{40}\text{Ar}/^{39}\text{Ar}$ -age of the Talakhtakh diatreme rocks (Arctic Siberia)

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To the east of the Anabar shield (Russian Arctic Zone), ultra-K alkaline-base complexes are distributed, which are represented by blast tubes, less often dikes, veins and stocks. One of the brightest representatives of this complex is the Talakhtakh diatreme, which is located among the Middle-Upper Riphean dolomites (MP3-NP2) and is opened in the left side of the Kuonamka River (Anabar district) (Fig. 1). The rocks composing the Talakhtakh diatreme were described as eruptive breccias of alkaline basaltoids, ultra-potassium trachytes, lamproites, impact breccias and impactites and were isolated in the Talakhtakh hypabyssal complex of alkaline basaltoids (Gusev et al., 2016). The rocks contain clastic material represented by carbonates, basic alkaline effusions, less often dolerites and crystalline basement rocks. The cementing material, often almond-stone, is chloritized, with porphyry secretions of sanidine, pyroxene, serpentized and chloritized olivine (Fig. 2, 3).

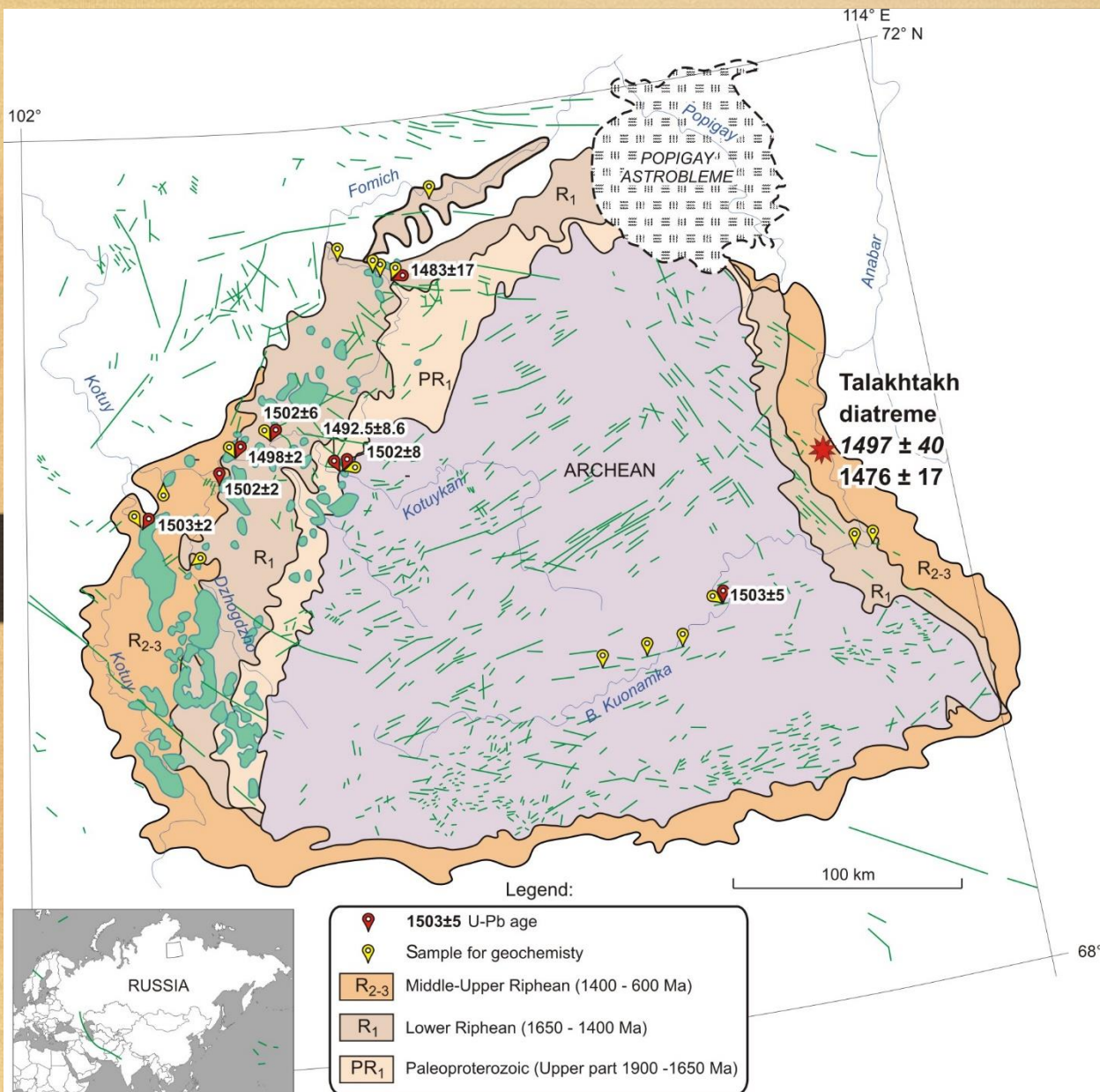


Fig. 1. Data on the age of dikes and sills within the Kuonamka LIP from the Anabar shield (Archean) and Mesoproterozoic-Neoproterozoic sedimentary cover (according to Ernst et al., 2016), with the point of radical exit of rocks of the Talakhtakh diatreme and age values (our data). Dikes (shown in green) have a wide range of ages from Proterozoic to Paleozoic; dikes of the E and NE strike located along the Bolshaya Kuonamka River and sills (shown in green areoles) located in the Riphean sedimentary rocks in the west of the Anabar Shield belong to the Kuonamka LIP.

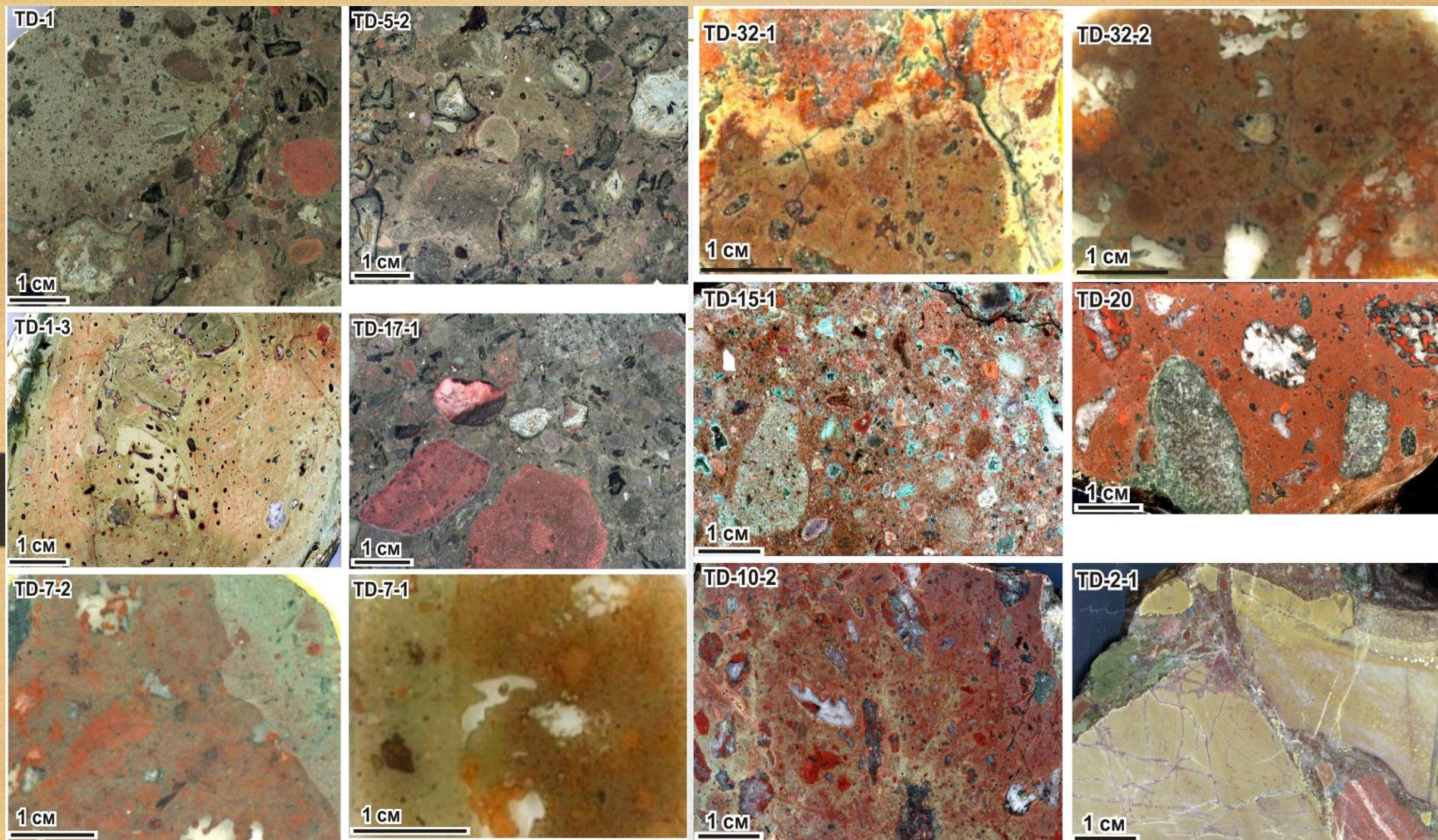


Fig. 2. General view of the rocks of the Talakhtakh diatreme. Group 1-tuffs of trachybasalts: TD-1, TD-5-2, TD-1-3, TD-17-1, TD-7-2; group 2-leucite trachytes (lamproites): TD-7-1, TD-32-1, TD-32-2, TD-15-1, TD-20, TD-10-2; dolomite breccia-TD-2-1.

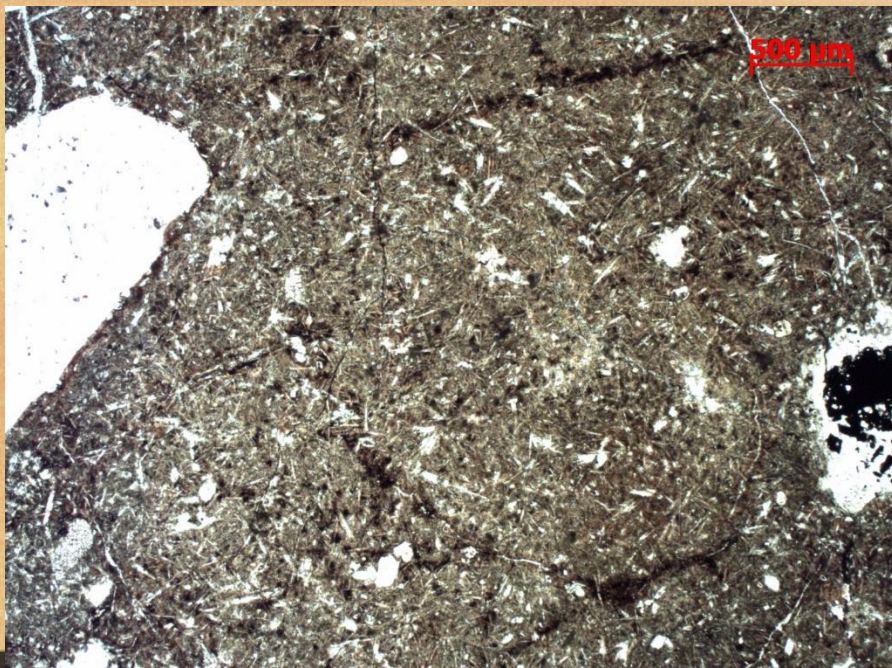
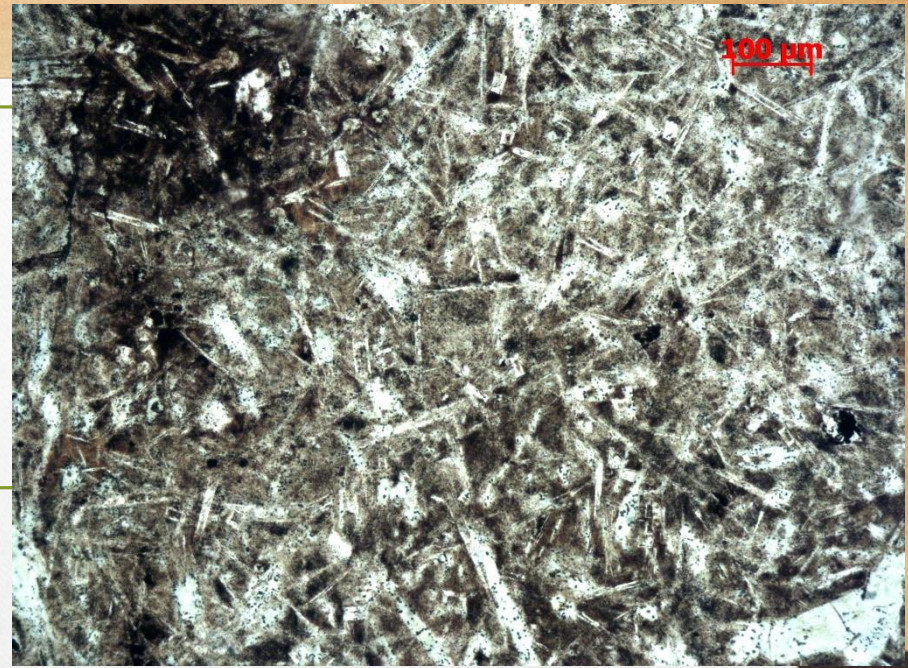
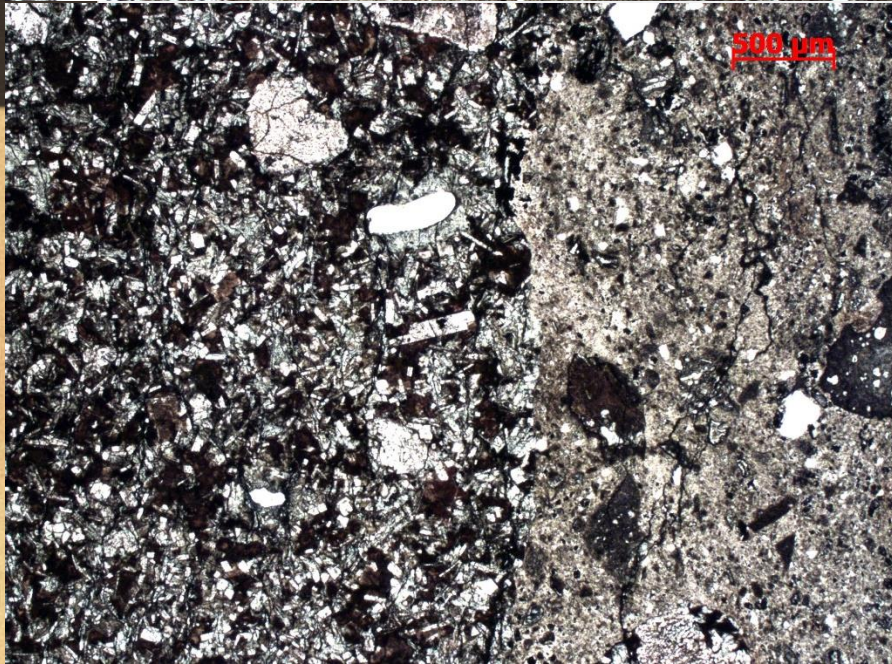
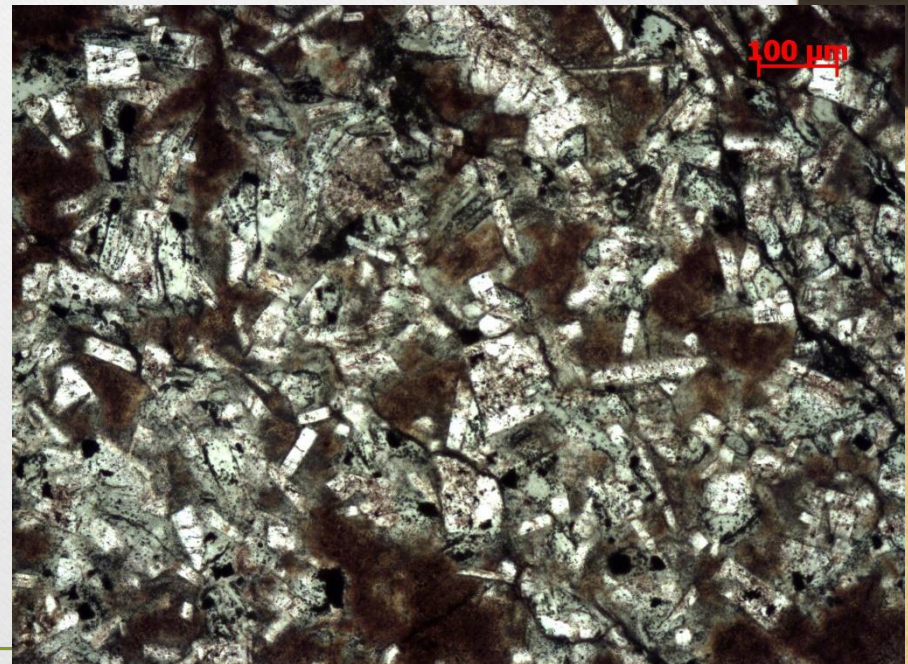


Fig. 3. Micro photo of rocks from the Talakhtakh diatreme. Top sample TD-32; bottom TD-7.

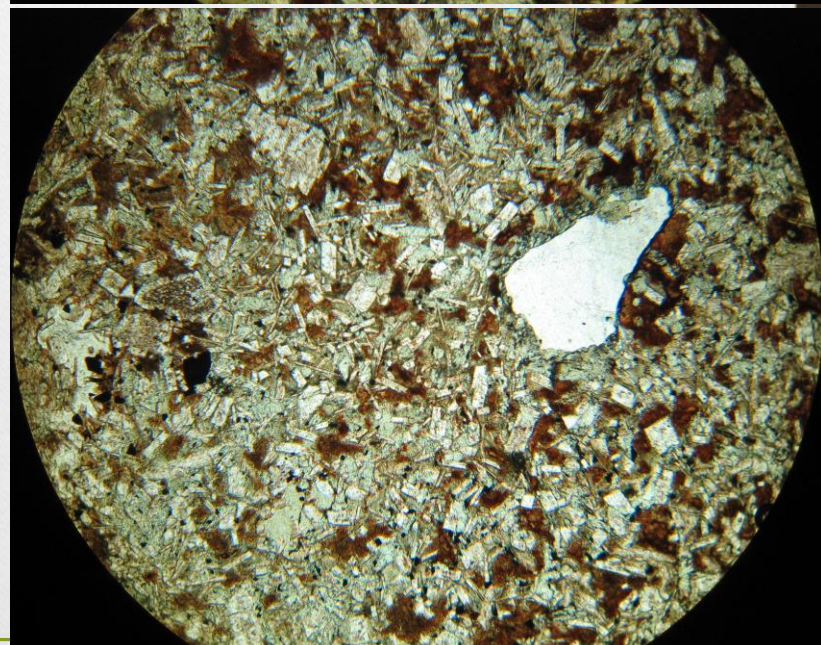


Fig. 3. Microphoto of rocks from the Talakhtakh diatreme. Top sample TD-7; bottom TD-32.

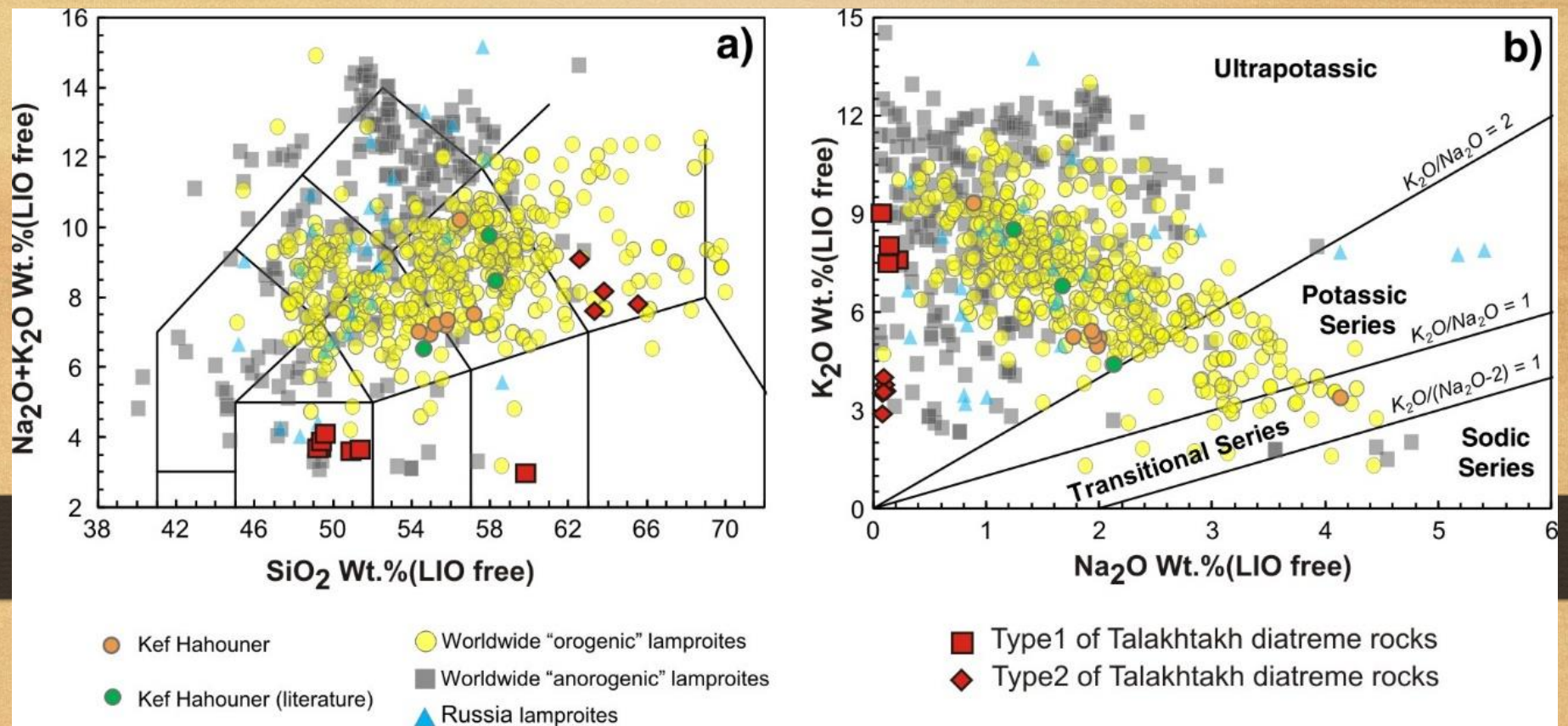


Fig. 4. Classification plots for the Talakhtakh diatreme rocks. Data for worldwide orogenic and anorogenic lamproites (from Lustrino et al., 2016) is reported for comparison. Russian lamproites are plotted with a different symbol because their trace element content falls in the "orogenic" field, but their Sr-Nd-Pb isotopic ratios fall in the "anorogenic" field. a) Total alkali vs. silica (Le Maitre et al., 1989); b) K_2O vs. Na_2O showing the fields for ultrapotassic, potassic, transitional and sodic alkaline series (Le Maitre et al., 1989).

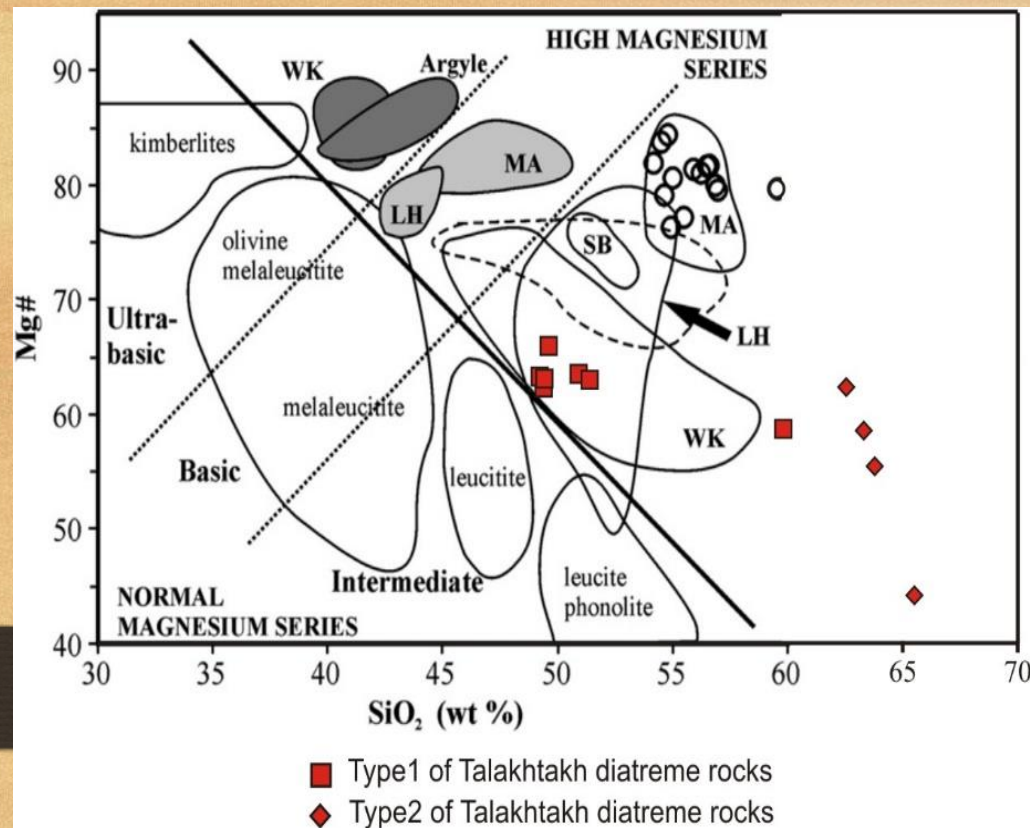
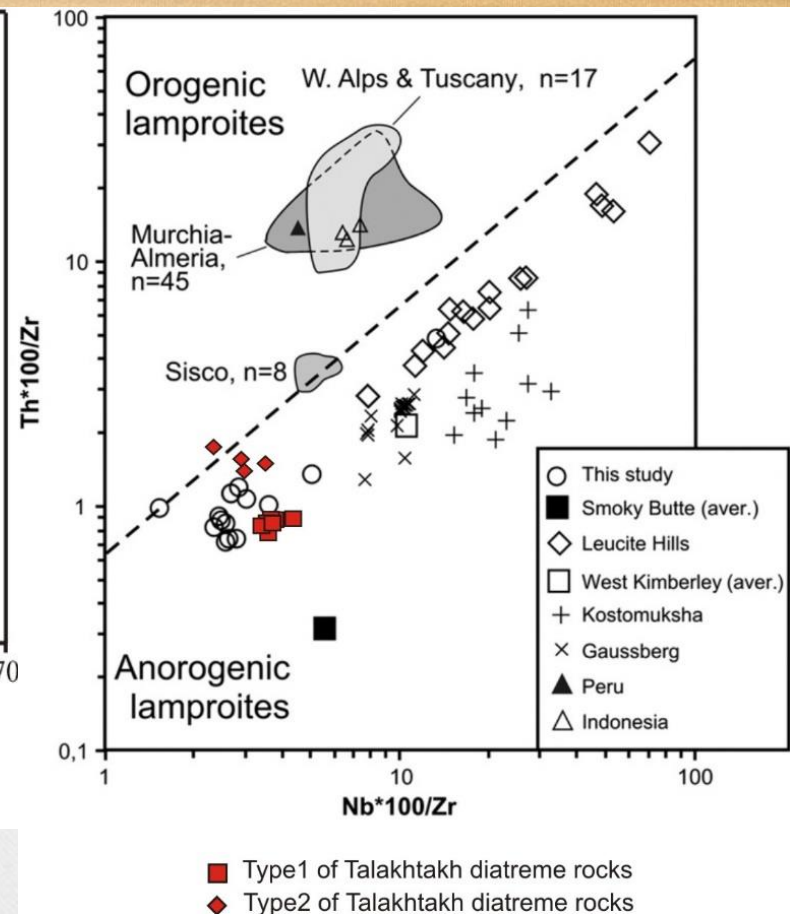


Fig. 5. Compositional data of the Talakhtakh diatreme rocks in the SiO_2 versus $\text{Mg\#}$ classification diagram for potassic rocks of normal-magnesium (leucitites, leucite phonolites, kimberlites) and high-magnesium (lamproites) series (solid diagonal line separates between the two series; modified after Bogatikov et al., 1991). Based on SiO_2 content, the ultrabasic, basic and intermediate families are indicated and separated with dotted diagonal lines. Lamproite occurrences: WK—West Kimberley; SB—Smoky Butte, LH—Leucite Hills; MA—Murchia–Almeria. Dashed line outlines the minette field (Kullerud et al., 2011).

Fig. 6. Nb × 100 / Zr vs. Th × 100 / Zr discrimination diagram for orogenic and anorogenic lamproites (after Beccaluva et al., 1991; Karmalkar et al. 2014). The Talakhtakh diatreme rocks is represented by the red squares and diamonds. Data source for type localities: Mediterranean lamproites: West Alps, Tuscany, Murchia–Almeria from Duggen et al. (2005), Prelević et al. (2008) and Conticelli et al. (2009); average values for Smoky Butte from Mitchell and Bergman (1991), Leucite Hills from Mirnejad and Bell (2006), Kvaløya (Kullerud et al. (2011), Chelima (Chalapathi Rao (2007)), Gondwana (Srivastava et al. (2009), Krishna (Paul et al. (2007) and World lamproite Bergman (1987).

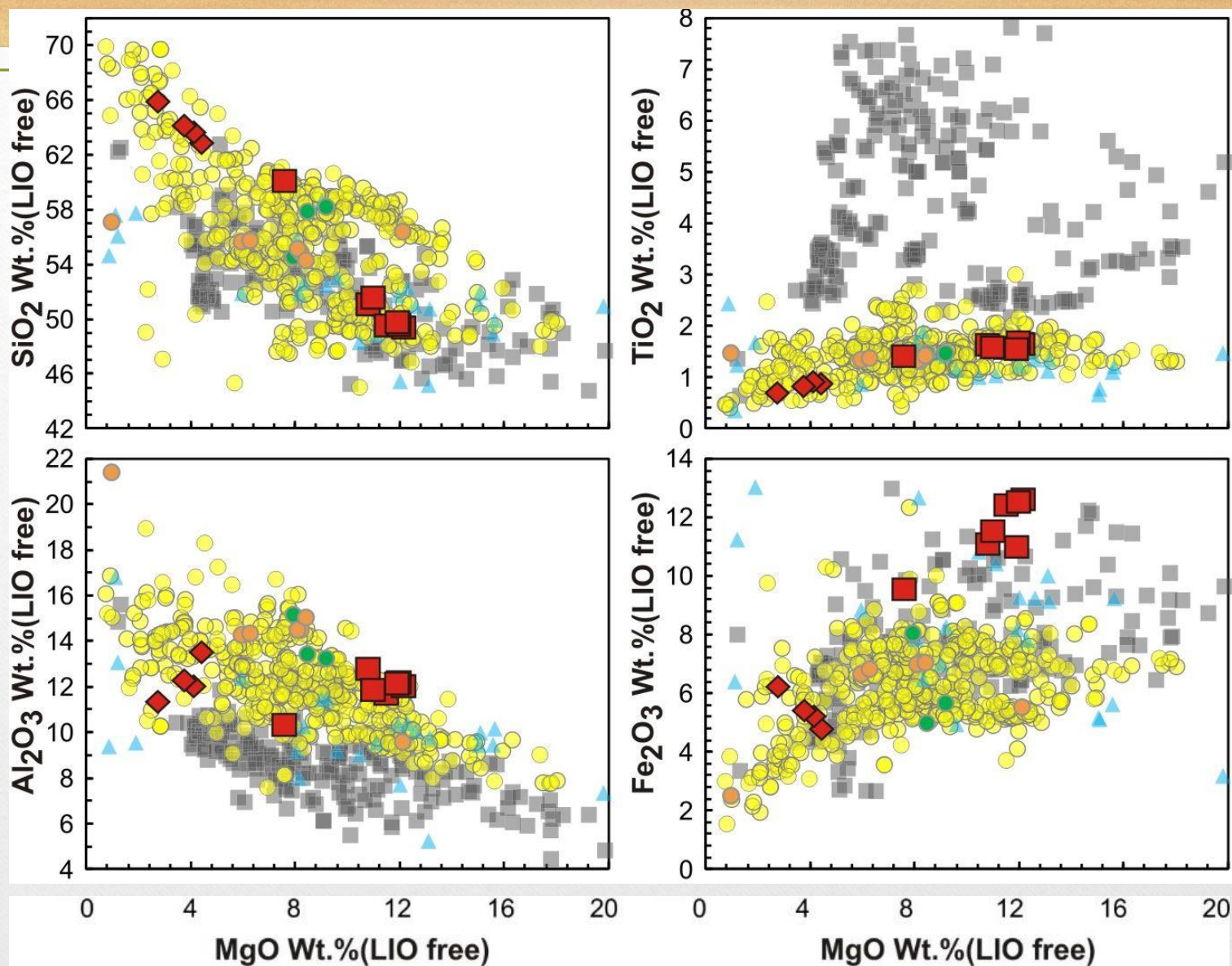


Fig. 7. Major element variation diagrams vs. MgO for the Talakhtakh diatreme rocks. Data for worldwide orogenic and anorogenic lamproites (Lustrino et al., 2016) are reported for comparison.

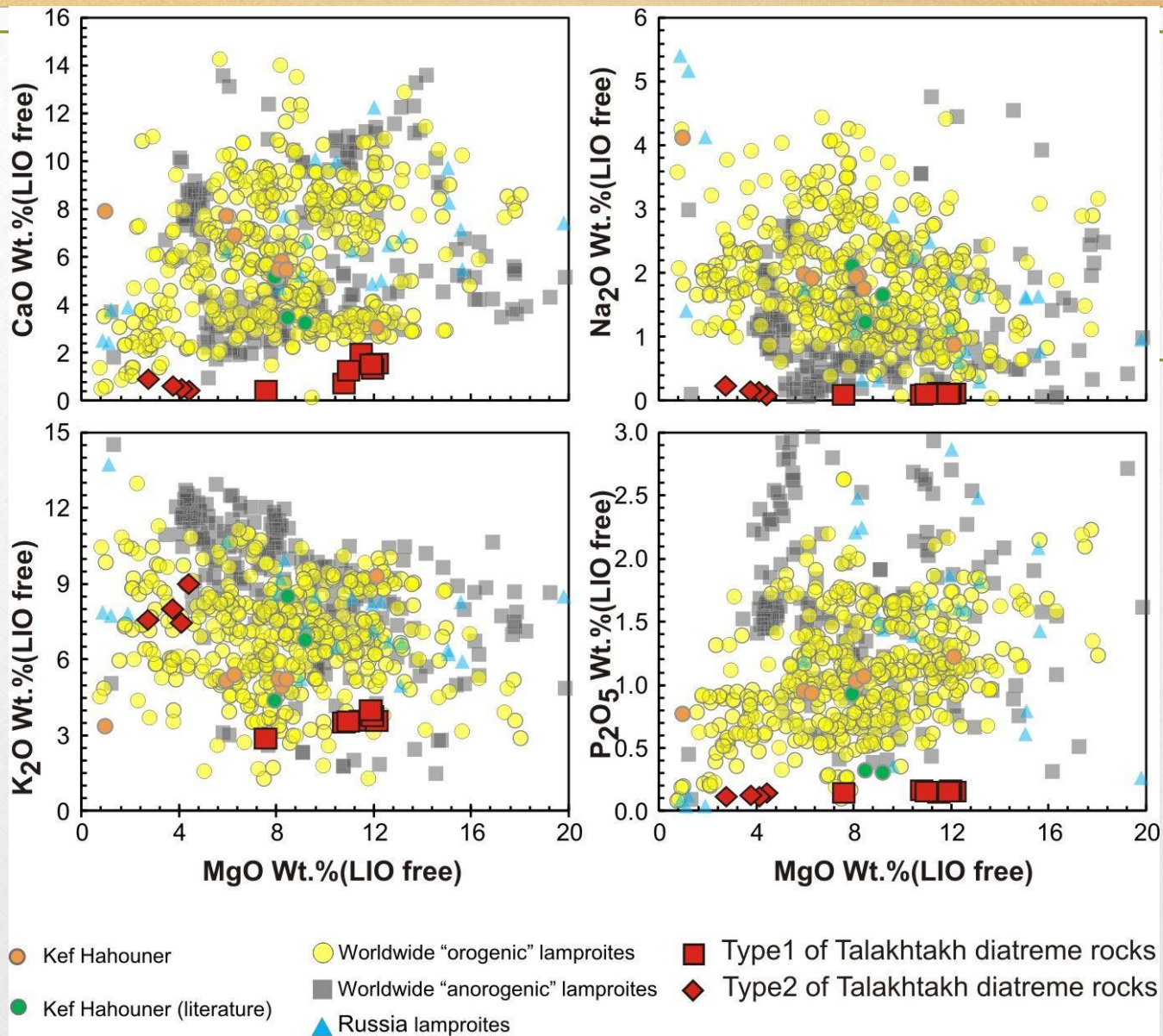


Fig. 7. Major element variation diagrams vs. MgO for the Talakhtakh diatreme rocks. Data for worldwide orogenic and anorogenic lamproites (Lustrino et al., 2016) are reported for comparison.

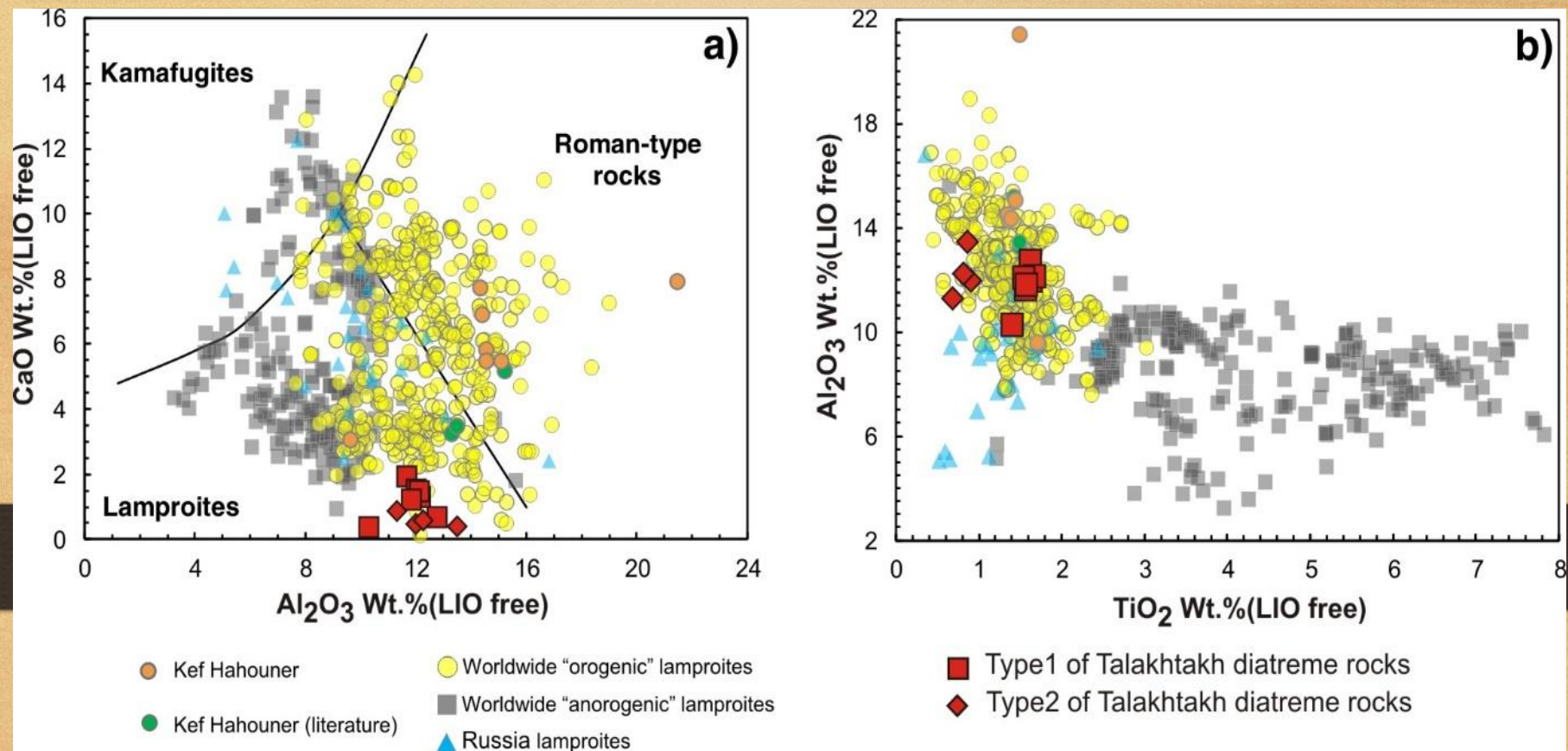


Fig. 8. CaO vs. Al₂O₃, showing the fields for ultrapotassic kamafugites, lamproites and Roman-type rocks (Foley et al., 1987), and Al₂O₃ vs. TiO₂ diagrams for the Talakhtakh diatreme rocks. Data for worldwide orogenic and anorogenic lamproites (Lustrino et al., 2016) are reported for comparison (Lustrino et al., 2016)

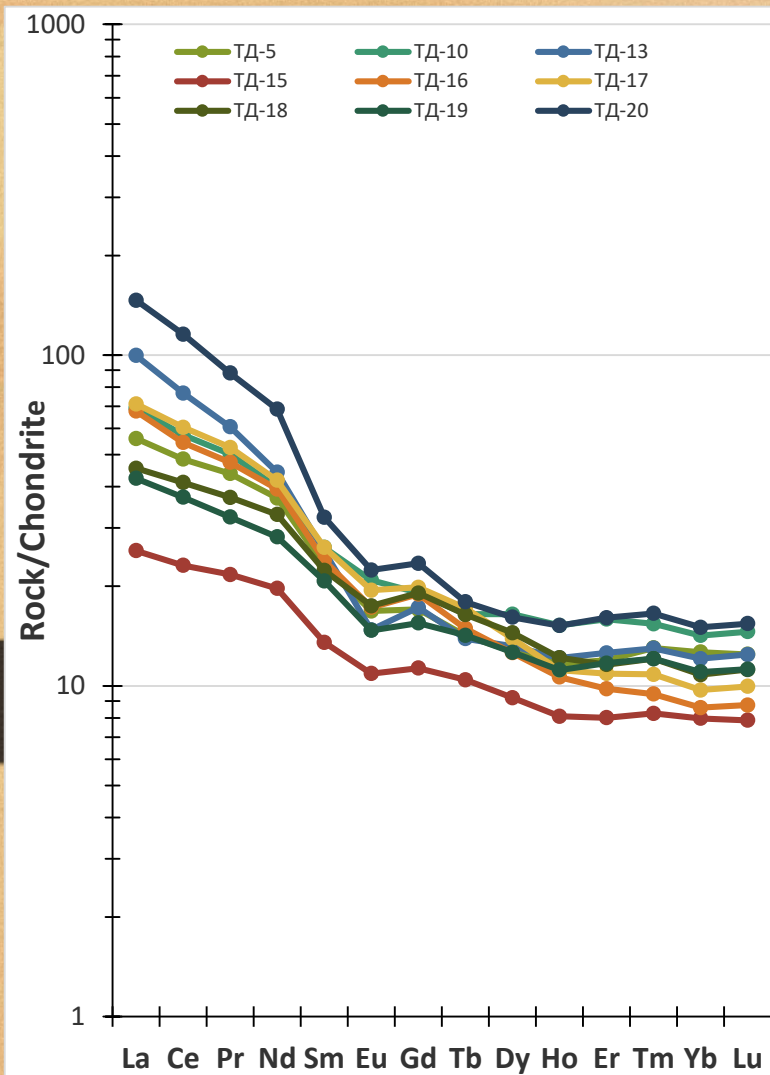


Fig. 9. Chondrite-normalized REE patterns for the Talakhtakh diatreme rocks.

Type1 – TD-5, TD-15 – TD-19;
Type2 – TD-10, TD-13, TD-20.

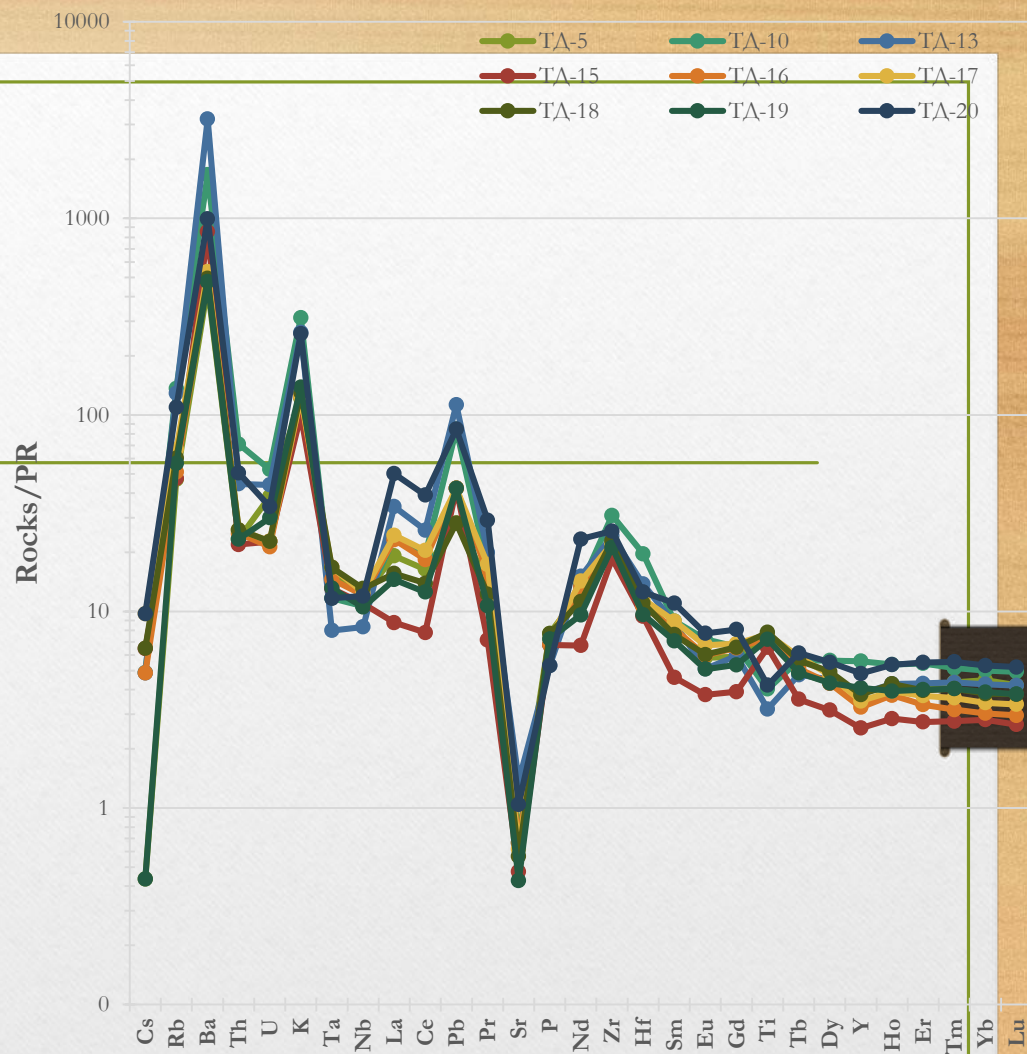


Fig. 10. Primitive mantle-normalized (McDonough, Sun, 1995) incompatible element plot for the Talakhtakh diatreme rocks. Type1 – TD-5, TD-15 – TD-19; Type2 – TD-10, TD-13, TD-20.

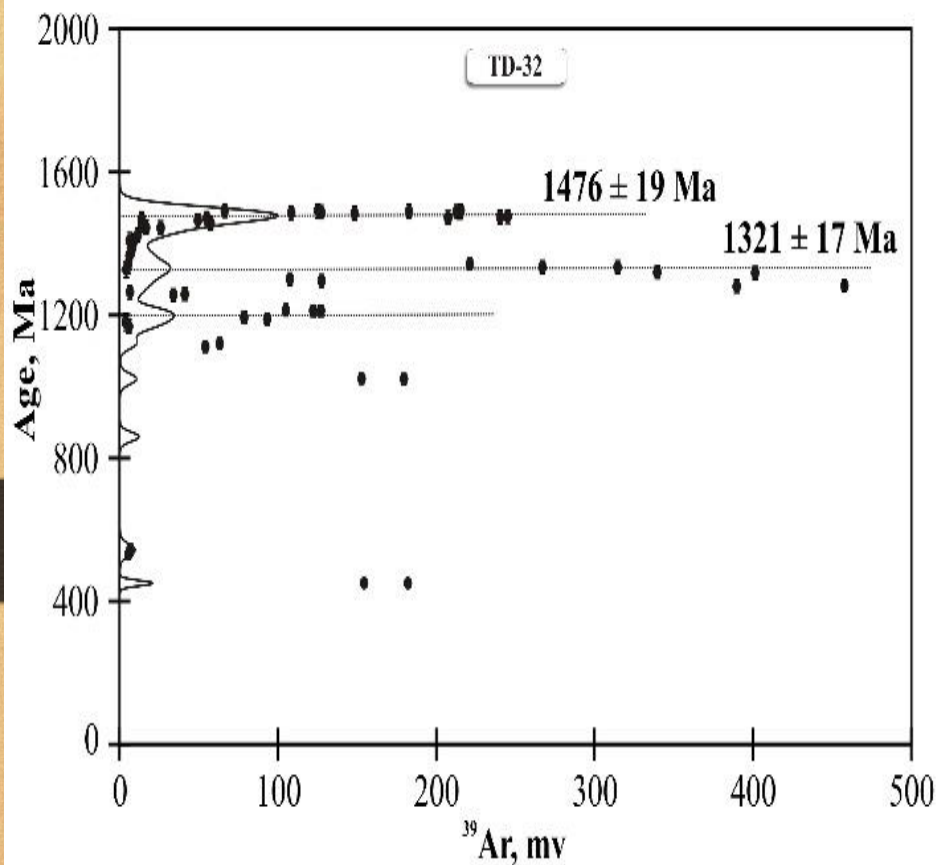
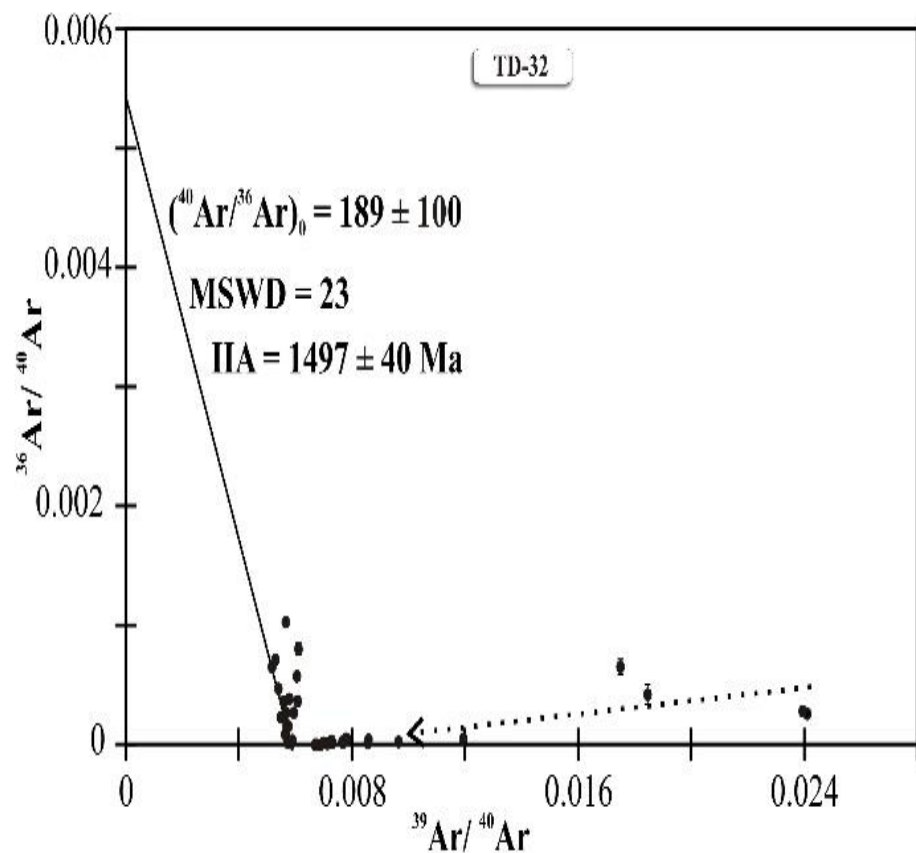


Fig . 11. Results of $^{40}\text{Ar}/^{39}\text{Ar}$ laser dating of the TD-32 sample of the Talakhtakh diatreme.

Figure 11 shows the results of $^{40}\text{Ar}/^{39}\text{Ar}$ laser dating of the TD-32 sample in relation to the measured age and intensity of the isolated ^{39}Ar . The diagram highlights two maxima for which, for varying intensity values over a wide range, age values that are consistent within the error range are obtained. The calculated weighted average age was 1476 ± 17 (N = 14) and 1321 ± 17 (N = 9) Ma. In the isochronous diagram, the experimental points are located along and between two linear trends. If 10 points form a linear regression, with an age value of 1497 ± 40 million years, an initial ratio of 189 ± 100 , then most of the remaining points are located along the abscissa axis. This arrangement may be associated with different degrees of rejuvenation of the K/Ar isotope system within the dated sites. Also, most of the points from the second maximum are located along the abscissa axis. Thus, the age value of 1497 ± 40 Ma fixed by linear isochronous regression, or the weighted average of 1476 ± 17 , as more accurate, corresponds to the age of sample formation.

Conclusions

According to petro- and geochemical data, at least two types of rocks are distinguished: green tuffs corresponding to the composition of trachybasalts and sealing wax with inclusions of trachyte sanidine. In general, rock compositions vary from olivine leucitites, tephrites, and alkaline basalts to trachyandesites and trachytes. Discrimination diagrams, REE distribution, and the nature of multicomponent graphs indicate the proximity of sanidine trachytes of the Talakhtakh diatreme to lamproites. Talakhtakh diatreme rocks have signs of orogenic and anorogenic lamproites.

R. Ernst et al. (2016) justified the new Kuonamka Large Igneous Province (LIP), based on U-Pb dating of baddeleyites isolated from dolerite dikes and sills of the Anabar shield. The age of Kuonamka LIP is $\sim 1501 \pm 3$ Ma. The resulting $^{40}\text{Ar}/^{39}\text{Ar}$ is the age of leucite trachytes (lamproites). The Talakhtakh diatreme fully corresponds to the time of occurrence of the Kuonamka LIP and indicates the formation of high-K effusions of the Talakhtakh complex during this period.



Thank you for your attention!