

## **MANTLE XENOLITH IN THE MAFIC DYKE AT BEREMEND, VILLÁNY MTS., SW HUNGARY**

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### **ABSTRACT**

Spinel lherzolite nodules of an U. Cretaceous mafic dyke in the Villány Mts. were studied. The xenolith consists of olivine, enstatite, Cr-diopside and Cr-Fe spinel as primary phases. No garnet or plagioclase is present. Alteration of the rock resulted in breakdown of olivine and formation of calcite, limonite and clay minerals. These processes can geochemically be followed by a significant loss of Mg and Ni as well as a gain of Ca relative to an average spinel lherzolite.

*Key words:* spinel lherzolite, alteration, Villány Mts.

### **INTRODUCTION**

Although, igneous rocks play only a subservient role in the Villány Mts., those crosscut the Aptian limestone at several places over the area may include fundamental information about the early Alpine evolution of the Tisia. There are two localities, where mafic dykes have been studied intensely, and partly reinterpreted in the last years, Beremend and Máriagyűd. Firstly, MOLNÁR and SZEDERKÉNYI (1996) reported essential petrographical as well as geochemical results about these rocks. They concluded that the subvolcanic bodies consist of altered basalt of unknown age. Further studies (NÉDLI, 1999, NÉDLI, M TÓTH, 1999/A) confirmed the mafic composition of the original igneous material and infer an alkaline character. Based on geochemical investigations they also suggest that the rocks developed on a mature island arc and are probably in relation with the U. Cretaceous ancient arc of the Vocin, Pozega region (Croatia). Recent microscopic observations resulted in textures similar to those characteristic of lamprophyres (NÉDLI, M TÓTH, 1999/B).

The basaltic material of both dykes studied contains xenoliths of different composition. In this study we present some early petrographical and geochemical results of the ultramafic xenoliths and xenocrysts.

### **PETROGRAPHY**

Both dykes studied crosscut Aptian and Albian carbonate rocks (Nagyharsány limestone - Urgon facies). Petrologically, the dykes are altered basalts and consist essentially of secondary phases, calcite and clay minerals (smectite, nontronite). In

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relatively fresh specimens two generations of *cpx*, as well as *ol*, *ap*, *ilm*, *mgt*, *amph*, *bio* and *pl* can be recognized as primary phases. Small, euhedral crystals of *ol* are usually present as pseudomorphs (Plate 1/1.). At places also well-developed mesh texture suggests previous *ol*. *Cpx1* forms large (250-500  $\mu$ ) euhedral grains, which at places contains also a xenocrystal core of *cpx* or *opx* (Plate 1/2.). *Ap* forms tiny laths in the matrix. While these grains represent the early stage of the crystallisation process, *cpx2* together with *amph*, *bio* and *ilm* should have crystallised subsequently. The latter three minerals usually occur in separated drops and possibly form ocelli.

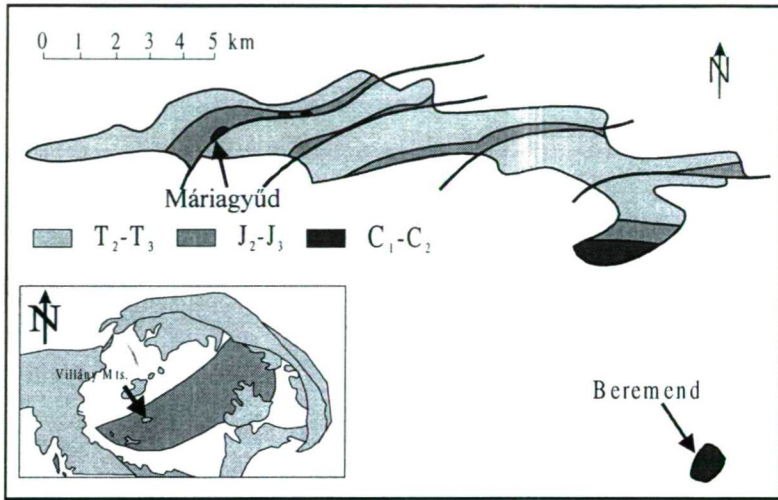


Fig. 1. Geological sketch map of the studied dyke

In addition to the *cpx*, *opx* and *ol* xenocrystals, highly altered xenoliths also occur in the two dykes (Plate II/1.). Based on microscopy as well as XRD and XRF data, these pale green, rounded, 2-8 cm large nodules consist of *opx* (enstatite), *cpx* (Cr-diopside), *Cr-spn* and minor *ol* as primary phases. No *ol* was able to be detected by XRD, its previous presence as a significant primary phase is suggested by the general mesh texture of the rock. No trace of previous *plag*, *gar* or *amph* can be recognized, the only Al-phase in each sample is *spn*. As secondary minerals, the nodules also contain a significant amount of *cc* and clay minerals. The xenoliths are spinel lherzolites petrographically.

## GEOCHEMISTRY

Major element composition, as well as Cr and Ni of two xenolith samples were measured by the standard wet chemical (MÁFI) and PIXE (ATOMKI) methods, respectively. Because of the significant amount of the CO<sub>2</sub> and H<sub>2</sub>O-bearing phases, composition was recalculated on a volatile-free basis. Data are collected and compared to the average composition of spinel lherzolites according to MAALOE, AOKI (1977) in Table 1. Although, both xenolith samples studied fall close the range of a typical spinel

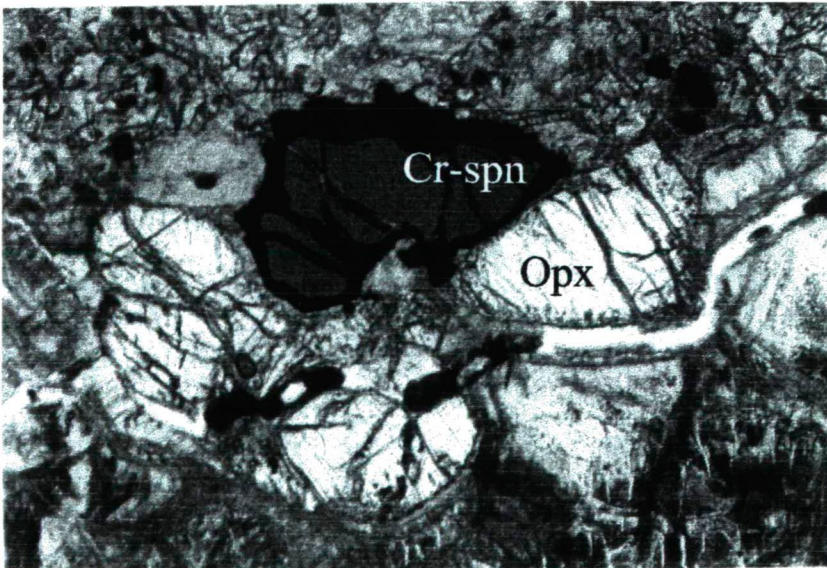
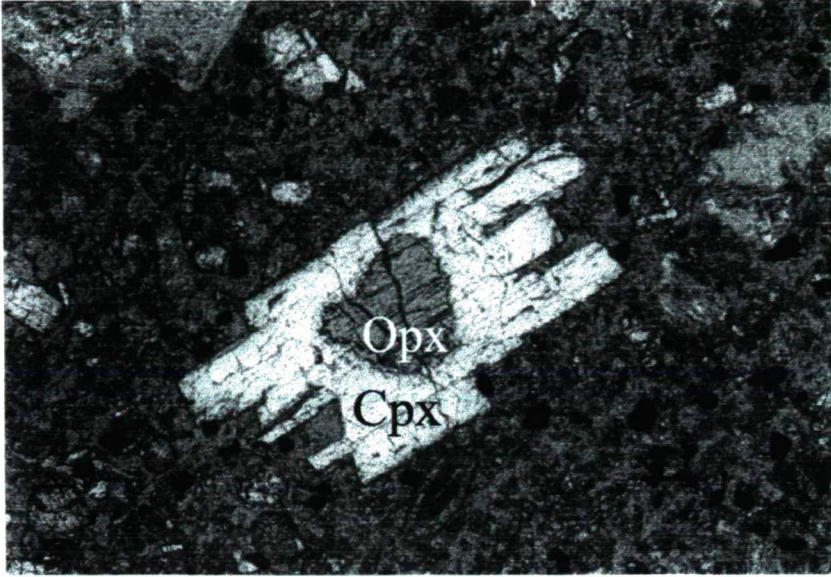


Plate I/1. Opx xenocrystal core of cpx1 in the host rock. N+, 36x  
Plate I/2. Typical texture of the xenolith with spn and opx. N , 72x



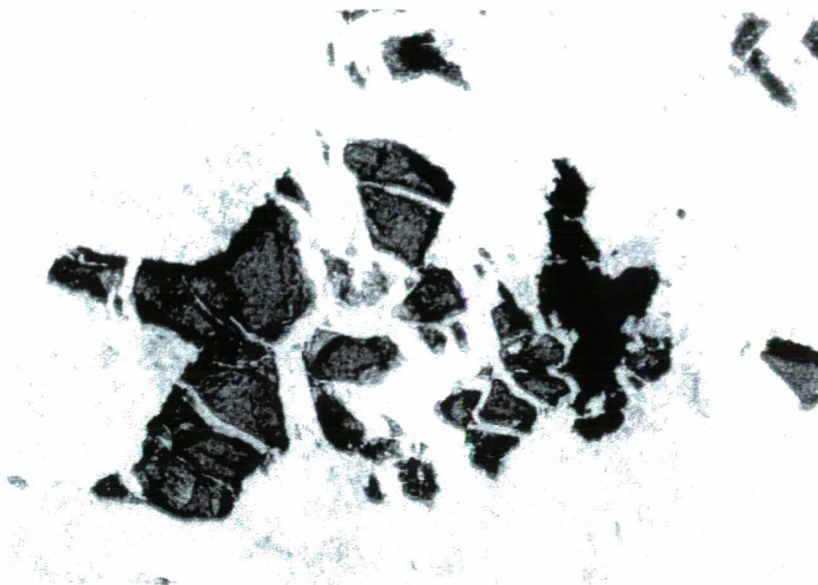


Plate II/1. Spn in an altered ol matrix. N , 72x  
Plate II/2. Mesh structure of the xenolith reminds the previous ol. N+, 36x

herzolite concerning most elements, a significant gain in Si, Al, Fe, Cr and Ca, while lost in Mg and Ni can be recognized. Proportion of Fe<sub>2</sub>O<sub>3</sub> and FeO (8.78, 1.19 for sample 6817/a, 8.66, 1.44 for sample 6817/b) shows the role of oxidation in addition to other alteration reactions.

TABLE I.

Composition of the two xenolith samples, the average spinel herzolite and the typical range for spinel herzolite (MAALOE, AOKI, 1977), respectively

Oxide (%) Element (ppm)	6817/a	6817/b	spinel herzolite <sup>1</sup>	Range for spinel herzolite <sup>2</sup>
SiO <sub>2</sub>	60.90	61.31	44.20	41 - 48
TiO <sub>2</sub>	0.08	0.25	0.13	0.0 - 0.2
Al <sub>2</sub> O <sub>3</sub>	4.22	6.92	2.10	0.5 - 4.5
FeO <sup>tot</sup>	10.48	10.30	8.30	7 - 10
MgO	14.97	13.38	42.20	39 - 47
CaO	8.97	7.47	1.90	0.5 - 4.5
Na <sub>2</sub> O	0.10	0.20	0.27	0.05 - 0.40
K <sub>2</sub> O	0.16	0.16	0.06	0.0 - 0.2
Total	99.88	99.99	99.16	
Cr	2360	1922	1505	680 - 2050
Ni	1348	1340	2200	1570 - 3140

## DISCUSSION AND CONCLUSIONS

The mafic dyke at Beremend contains a large amount of ultramafic nodules which were examined. Although no xenolith has been found in the dyke at Máriagyúd yet, based on the presence of *opx* and *ol* xenocrystals as well as the common *opx* core of basaltic *cpx1* crystals, a similar origin of the two subvolcanic bodies can be assumed. An analogous evolution was previously stated also by NÉDLI (1999) when studying the two mafic rocks petrographically and geochemically.

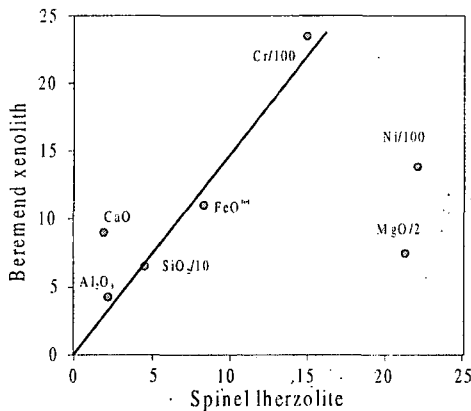


Fig. 2. Comparison of the composition of sample 6817/a to the average spinel herzolite (MAALOE, AOKI, 1977) on an isocon plot

When comparing chemical data of the two samples studied with those typical for the average spinel lherzolite (MAALOE, AOKI, 1977, see Table 1.) on a diagram suggested by GRESENS (1967) and GRANT (1986), one can follow the behaviour of the elements plotted during the alteration processes. On this plot (Fig. 2.) Si, Al, Fe and Cr lie along a straight line approximately, suggesting a similar degree of gain related to the original ultramafic rock. Both Ni and Mg decrease significantly, whereas Ca exhibits a considerable increase. This kind of geochemical nature of the elements is consistent with the petrographical observations. Alteration of *ol*, which is the main Mg and Ni phase in the rock resulted in formation of the typical mesh texture and subsequently the loss of Mg and Ni. XRF data show that both *spn* and *cpx* contain a large amount of Cr. These minerals show no (*spn*), or only partial alteration in good agreement with the immobile behaviour of Cr. Although, Fe had to escape from *ol* as  $Fe^{2+}$ , it could form  $Fe^{3+}$  minerals (limonite) under the oxidising conditions. Consequently, Fe as  $FeO^{tot}$  is immobile. In addition to the Ca-bearing ultramafic phases, also an external Ca-source had to take part in formation of carbonate minerals in the xenolith. The same was stated for the mafic host rock by NÉDLI and M TÓTH (1999/A).

Concluding the geochemical data, one can state that the chemical composition of the original xenolith may have been comparable to spinel lherzolite prior to the alteration processes. The composition changed mainly due to the breakdown of the *ol*, and because of *cc* precipitation in part from external Ca-source. The increase of Si, Al, Fe and Cr can be considered to be virtual.

The only Al-phase in each xenolith sample examined is Fe-Cr *spn*. The lack of *amph*, *gar* and *plag* in the case of the normal lherzolite chemical composition suggests formation in the PT range of 6 - 14 kbar, 850 - 1000 °C (BUCHER, FREY, 1994). This interval may represent the uppermost part of the upper mantle (ARAMUKI, UI, 1982). If it is so, the xenolith presented in this paper is the first direct sample from the mantle in the Hungarian part of the SW Tisia block. Thermobarometry, however, needs more work.

#### ACKNOWLEDGEMENT

XRD and XRF measurements were provided by BERTALAN Á. at the JATE, Szeged. SZABÓ GY. detected the trace elements at the ATOMKI, Debrecen. PONGRÁCZ, L., PÉRO CS., RÁLISCH-FELGENHAUER, E. and KASSAI, M. are thanked for serving hand specimens and thin sections. The DCM Limestone Mines Co. is gratefully acknowledged for making the field work and sampling possible. We have greatly benefited from discussions with SZEDERKÉNYI T.

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*Manuscript received: 10. September 1999.*