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To cite this version:

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HAL Id: insu-00990100

https://insu.hal.science/insu-00990100

Submitted on 14 May 2014

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Comment on "Geochronology and geochemistry of submarine volcanic rocks in the Yamansu iron deposit, Eastern Tianshan Mountains, NW China: Constraints on the metallogenesis" by Tong Hou, Zhaochong Zhang, M. Santosh, John Encarnacion, Jiang Zhu, Wenjuan Luo [Ore Geology Review, 56(2014):487–502]

- Guangrong Li[ab]
- Changzhi Wu[c]
- Yannick Branquet[b]

- [a] Fundamental Science on Radioactive Geology and Exploration Technology Laboratory, East China Institute of Technology,NanChang, Jiangxi ,330013, China
- [b] Université d'Orléans et CNRS / INSU, ISTO - UMR 7327, Campus CNRS, 1A rue de la Férollerie, 45071 Orléans Cedex, France
- [c] State Key Laboratory for Mineral Deposits Research, Department of Earth Sciences, Nanjing University, Nanjing 210093, China

1. Introduction

In a recent paper, Hou et al., (2014) presented their study on the Yamansu iron deposit in eastern Tianshan Mountains, NW China. Hou et al., (2014) proposed a genetic model for the iron mineralization in Yamansu, which was based on geochronology and geochemistry study on volcanic rocks and skarns. In their paper, they gave an excellent discussion on the geochemistry data of basalt. However, we would like to address the following arguments:

(1) What are meanings of zircon U-Pb ages derived from the basalt and skarn?

(2) Did the Yamansu basalts provide the source of iron for the skarn mineralization?

2 What are meanings of zircon U-Pb ages derived from the basalt and skarn?

Hou et al., (2014) separated zircons from basalt and garnet skarn, and then dated by LA-ICP-MS. These zircons yielded coeval ages of 324.4 ± 0.94 and 323.47 ± 0.95 Ma for the basalt and skarn, respectively. These ages lead them to make the conclusion that the skarn formation in Yamansu deposit is related to subaqueous volcanism. Here, we may ask what the relations between the basalt and the skarn are. In addition, we need to know what the protolith of these skarn is, and what triggered the skarnization. If observations in the field proof the skarn were obviously later than the basalt, Hou's conclusion seems untenable.

2.1. Skarnization

Within the massive garnet ribbons, relics of basalt were observed (Fig. 1A). These basaltic ghosts vary in size from a few to about 30 cm and show irregular rounded shapes with gradational and wavy boundaries. Sparse idiomorphic pyrites develop in the basaltic relics. In some places, far from massive garnet ribbons and magnetite bodies, basalts are partially replaced by andradite growing in the groundmass, whereas the plagioclase seems being little

replaced (Fig. 1B and 1C). All these observations support the idea of a replacement of basaltic protolith into garnet skarn.

No relation is observed in altered basalts between massive magnetite and garnet growth. Massive magnetite bodies are of two types: (i) massive magnetite lobes replacing marble show a reaction front outlined by garnet growth (Fig. 2), the progression of the magnetite replacement front is marked by integration and growth of garnet within massive magnetite. The advancing front yields to corrosive brecciation of marble and produces garnets; (ii) massive magnetite lenses in the centre of Yamansu open pit present a rhythmic banding pattern composed by alternation of magnetite and garnets ribbons. For the second type, sparse garnet grains were observed. (See Fig. 1.)

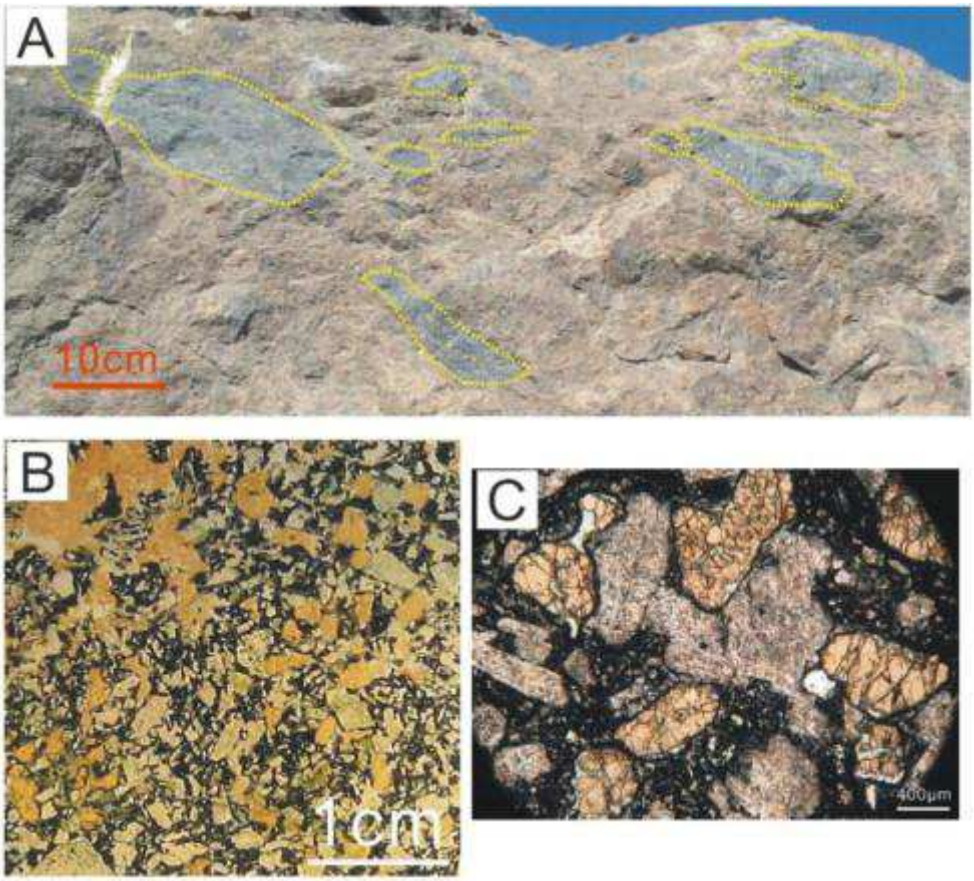

Fig. 1. : Skarnization of the basalt and limestone. (A) Relics of basalt (emphasized by dotted yellow lines) in massive garnet skarn (pale rose). (B) Polished hand specimen showing andradite alteration in pink color of basalt; plagioclases are in white color; fine grain groundmass and disseminated magnetite are in black; (C) photomicrograph showing the andradite alteration on the groundmass of the basalt (in transmitted plane polarised light).

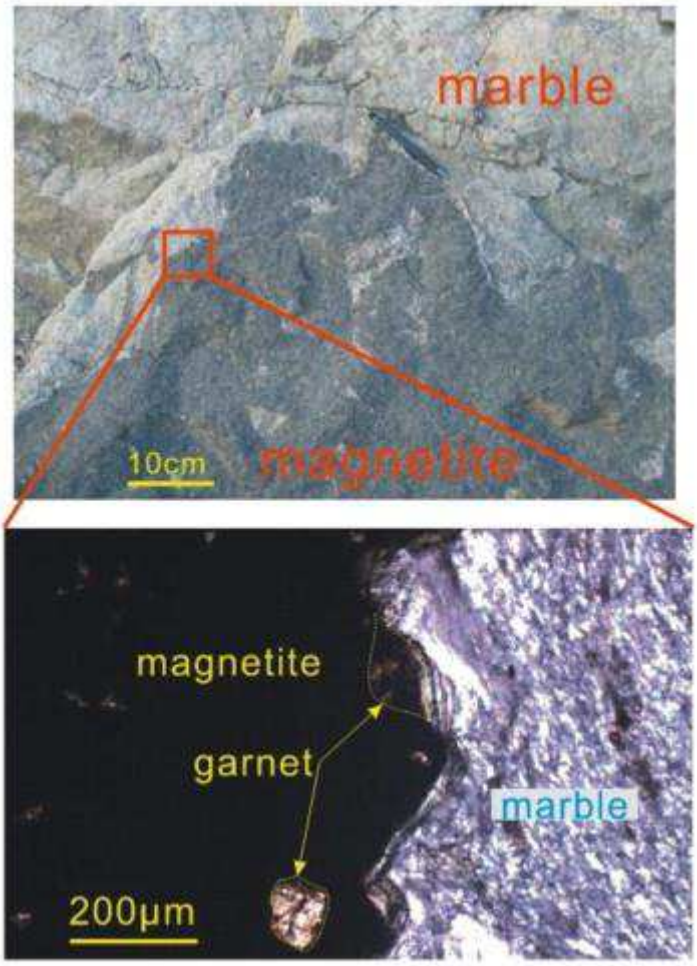

Fig. 2. : Contact between the marble and the massive magnetite ore shoot showing the advancing iron-rich front at the contact magnetite mineralization and marble. This front is outlined by garnet growth (in transmitted plane polarized light).

So, these observations support the idea that: (1) the basalt and the limestone were protolith. In other way, it is normal to gain coeval ages for the basalt and the skarn, because basalt was altered into skarn and the refractory zircon stayed; (2) skarnization was triggered by iron-rich fluid. Detail presentations refer to Li (2012) and Li et al., (2013).

2.2. Zircon age

We would like to dispute that these zircons derived from the basalt and skarn probably are detrital zircons because contamination happened during the emplacement of these basalt (Fig. 3). By coincidence, the limestone yielded fossils was identified to by late Carboniferous (XBGMR, 1993).

Fig. 3. : Fragment of marble within strongly altered basalt, suggesting mafic magma stoping. The photo was taken in the gallery, about 200 m underground. Around the fragments of marble, potassium metasomatism developed (the pale red part near the hammer). After Li (2012).

3. Did the Yamansu basalts provide the source of iron for the skarn mineralization?

In a study of metasomatical altered rocks, the immediate questions concern the nature of the original rock and the gains and losses of material necessary to produce the altered rock. By careful consideration of the field relations and petrology of an area, one maybe able to determine a "least-altered equivalent". This is probably the major step in unraveling the alteration process. Assuming that this has been done, one has to consider next the basis for determining the relative gains and losses that gave rise to the altered rock. In some cases the assumption of constant volume seems to work, in some, constant alumina, and in other cases, other components seem to have been relatively immobile. In this study, mass balance was quantified during alteration. Major compositions of least altered basalt (samples Y159) and altered rock (massive garnet skarn sample Y102) are listed in Table 1 which is utilized in mass-balance calculations to estimate gains and losses of components in the samples. The calculations were conducted by the isocon method (Grant 1986), which is a solution to the composition-volume relationships of Gresens' equations (Gresens 1967). For the mass balance, least altered basalt and the garnet skarn were taken as original and final, respectively. The detailed treatment of the calculations and the isocon fitting follows Grant (1986).

Table 1. : Geochemical compositions of basalt, massive garnet skarn and related mass balance calculations according to Grant (1986).

samples	basalt Y159	skarn Y102	Δm_i(g) from Y159 to Y102
SiO_2	46.15	42.52	− 0.55
TiO_2	0.85	0.58	− 0.23
Al_2O_3	21.20	15.30	− 4.79
MgO	4.10	3.39	− 0.46
CaO	7.68	20.32	14.11
Fe_2O_3	5.22	8.07	3.43
FeO	3.72	3.64	0.18
MnO	0.55	0.34	− 0.19
P_2O_5	0.09	0.11	0.03
Na_2O	1.78	0.23	− 1.53
K_2O	4.38	2.10	− 2.13
LOI	4.39	3.69	− 0.43
∑	100.11	100.29	
ρ (g/cm^3)	2.82	3.36	
f_V			0.9

Δm_i (in grams) gain or loss of elements during the transformation of basalt into massive skarn; positive value means gain, whereas negative value means loss. ρ = density; f_V= volume fator.

The calculations give the mass-balance relation referenced to 100 g of basalt protolith for the garnet skarn, as following:

100 g basalt + 14.1 g CaO + 3.4 g Fe_2O_3

= 107.4 g skarn + 4.8 g Al_2O_3 + 2.1 g K_2O + 1.5 g Na_2O (from Y159)

Mass gains and losses of mobile major element oxides are calculated from such an isocon and reported in Table 1. The predominant changes are gains of CaO and a loss of Al_2O_3 in the basalt. This result suggests that CaO from the limestone is added to the basalt, whereas Al_2O_3 is leached out, during alteration. Extra iron was added during skarnization.

4. Uncited references

Gresens, 1967

Grant, 1986

Hou et al., 2014

Li, 2012

Li and Wu, 2013

XBGMR, 1993

Acknowledgements

We appreciate support from the doctoral starting-up project (DHBK2012209) and the National Natural Science Foundation of China (No.40603008 and 40672040). We thank Dr. Lianxing GU from Nanjing University (China) for the valuable suggestions, which have helped to improve the paper.

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