The microstructure of Trinitite, the glassed sand from the first nuclear explosion

A.J. FAHEY* AND D.E. NEWBURY

National Institute of Standards and Technology, Gaithersburg, MD 20899-8371, USA (dale.newbury@nist.gov) (*correspondence: albert.fahey@nist.gov)

In July of 1945 the first test of technology for a nuclear weapon was conducted on the White Sands Proving Ground in New Mexico. The glassed sand that bears witness to the test is commonly referred to as Trinitite. Apart from several studies of the radioactivity in the material the only published work discussing the material from a mineralogical perspective was written in 1948 [1].

Most trinitite is a green glass that has a top 'fused' side that grades into the soil over 1-2 cm of depth. Trinitite is laden with vesicles that range in size from micrometers to nearly the thickness of the material. According to Ross [1], two types of glass were formed, one from the feldspars, clays and accessory minerals and the other from quartz. The silica glass mostly kept its original shape whereas the glass from the feldspar shows evidence of flow. We have found unusual features in a thin section of trinitite. These features show the effects of rapid melting and cooling.

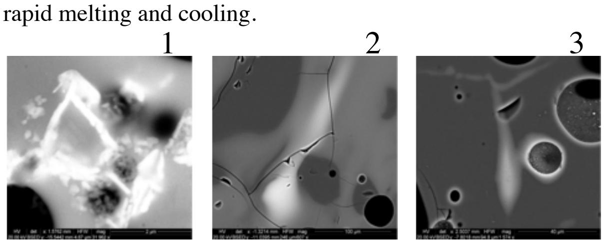

Figure 1: 1) Image (~5 µm across) of Ti-whiskers in melt, 2) Image (~250 µm across) of Zr-streak in melt, 3) Image (~100 µm across) of immiscible Fe spheres populating an elongated region near vesicles decorated with Fe spheres.

Micro-structure shown in Fig. 1 is not completely unexpected but is somewhat confusing. Specifically, it is surprising that a 'streak' of Zr-rich material (1-2) would form in the lower-temperature melt area but much of the quartz in the section appears un-melted. If the Zr-streak were once a zircon then we might expect it too, to be unmelted. Small whiskers of Ti appear in the melt near a vesicle (1-1) and spheres of Fe-rich material ranging in size from 300 nm down to <10 nm. Not shown are also inclusions of Y, Ba, and others. It may be that some of these unusual inclusions have their origin not as part of the original soil but as part of the weapon debris. If these unusual inclusions can be shown to have originated in the weapon then one may be able to discern clues that aid in its attribution. A key outcome of any forensic investigation of post-detonation material will be attribution. Further analysis must be performed to glean information. New data and other findings will be shown and discussed.

[1] Ross (1948) *Am. Mineral.* **33**(5,6), 360–362.

Phase trasition from spinel lherzolite to garnet lherzolite in upper mantle of eastern China and its significance

QICHENG FAN, JIANLI SUI AND BIN HAN

Institute of Geology, China Earthquake Administration, Beijin 100029 (fqc@ies.ac.cn)

It is well known that the upper mantle is stratified, either by petrological or geochemical layers. Mantle xenoliths, compared with garnet lherzolites from Sulu UHP belt, provide evidences of petrological (Sp to Gt transition) and geochemical variations of the upper mantle in eastern China.

Spinel peridotites is wide spread in Cenozoic basalt in eastern China, while garnet bearing lherzolites only occur in several Cenozoic volcanic fields, e.g. Mingxi, Xilong, Hebi, Nushan, Hannuoba and Chaoerhe. P-T estimation by E-probe data reveal the petrological stratigraphy beneath the subcontinental lithospheric mantle of eastern China, as (1) Spinel lherzolites compose the uppermost mantle, (2) Sp/Gt lherzolites occur from 55-70 km, with temperatures of 1039-1182°C, and (3) Gt lherzolites occur more than 70km, with 115-1199°C.

Rock type	Localities	*T*(℃)	*P*(GPa)	D(km)
Sp/Gt	Mingxi	1058	2.05	66
Lherzolite	Xilong	1103	1.93	62
	Nushan	1114	1.91	62
	Hebi	1039	1.97	64
	Hannuoba	1182	1.89	61
Gt	Chaoerhe	1164	2.36	76
Lherzolite	Xinchang	1115	2.47	79
	Minqing	1199	2.43	77

Table 1: *P*-*T* estimation for garnet-bearing peridotites in Cenozoic basalts from eastern China
T (°C)—by Wells (1977), *P* (GPa)—by Nickel and Green (1985), D (km)=4.02+30.3*P*, Lallement *et al*. 1980.

Chemical variation and stratigraphy of these samples provide essential evidence of mantle dynamic evolution in depth and/or through geologic time. In eastern China, garnet lherzolites from Sulu UHP belt have extremely Al-poor pyroxenes (0-0.2%wt Al_2O_3); garnet peridotites trapped in Paleozoic kimberlites from over 200 km depth are relatively Al depleted (Al_2O_3<2%wt); and the garnet lherzolites in Cenozoic basalts are Al-rich (Al_2O_3 4-5%wt).

Supported by NSFC 40972047.