Unmasking enigmatic xenolithic eclogites: Progressive metasomatism on a key Roberts Victor sample

*JIN-XIANG HUANG[1,2], W. L. GRIFFIN[1], Y. GREAU[1], N. J. PEARSON[1] AND S. Y. O'REILLY[1]

[1]CCFS/GEMOC, Macquarie University, Sydney, Australia (*correspondence: jinxiang.huang@mq.edu.au)
[2]Institute of Geology and Geophysices, China Academey of Sciences, Beijing, China

Extensive studies of xenolithic eclogites have generated two contradictory hypotheses about their origin. One regards the eclogites as deep-seated magmatic rocks, while the other regards them as basaltic components of subducted oceanic slabs. To test the hypotheses, it is essential to find out if the samples being studied actually carry primary information.

Previous work on Roberts Victor eclogites (South Africa) divided the samples into Types I and II. Type I eclogites show sequential degrees of metasomatism by melts/fluids in the carbonatitic-kimberlitic spectrum; Type II eclogites may be the protoliths of Type I.

Progressive metasomatism inferred from studies of the whole eclogite suite, has now been revealed within one sample RV07-17. Four zones (progressively 1, 2, 3, and 4) are distinguished using the compositions of garnets. From Zone 1 to Zone 4, the microstructure becomes less equilibrated; secondary minerals and fluid inclusions become abundant; pyrope content of the garnets increases gradually; cpx shows progressive enrichment in MgO. The cross-cutting pattern strongly suggests that Zone 1 represents an early stage of the metasomatism, and Zone 4 the latest stage.

The garnets of Zone 1 have flat REE patterns from Lu to Sm, but a strong depletion in the LREE. Toward Zone 4, the relative abundance of the MREE of the garnets drops significantly, giving smoother patterns. A large cpx grain in Zone 1 shows a strong depletion in the LREE, but the LREE/MREE of the cpx increases from Zone 1 to Zone 4. From Zone 1 to 4, $^{87}Sr/^{86}Sr$ of cpx increases along with Sr content; $\delta^{18}O$ of the garnet decreases from ~8.5 to ~6.0 ‰ as the MgO content increases.

These observations indicate that the eclogite was metasomatized by Mg-rich melts/fluids, changing through time from carbonatitic to more kimberlite-like. The metasomatism has swept away all original information on compositions, making it nearly impossible to define a protolith. To know the origin of the xenolithic eclogites, and to use them as evidence for different dynamic scenarios, the least metasomatised samples must be studied more than has been done previously.

Carbon isotopic evidence for methane release during the end-Permian mass extinction

JUNHUA HUANG[1], LIDAN LEI[1], GENMING LUO[1,2] AND QUNFENG ZHOU[3]

[1]State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan 430074, China
[2]State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, Wuhan 430074, China
[3]Institute of Geophysics & Geomatics, China University of Geosciences, Wuhan 430074, China

The largest mass extinction in the Phanerozoic that occurred mainly at the end-Permian about 252 Ma ago, eliminated ~90% of marine invertebrate species and ~70% of terrestrial vertebrate species [3]. The succedent recovery of the whole marine ecosystem lasted for more than 5 Ma [2] This mass extinction was known to be accompanied by large perturbations in the global carbon cycle. However, the cause-and-effect relationship between the mass extinction and the global carbon cycle perturbation remains unclear [1].

Here we analyzed paired carbonate and organic carbon isotopic composition at the biostratigraphically-constrained Ganxi section which was located in northern deep water basin that attached to the Yangtze carbonate platform during the P-Tr transition. The $\delta^{13}C_{carb}$ underwent two episodes of negative shifts. The first one, from ~1.5‰ to 0‰, occurred before the main mass extinction horizon. The corresponding $\delta^{13}C_{org}$ also show a negative shift from ~-25‰ to ~-28‰. The second shift, from ~1‰ to -1‰, occurred at the lower Triassic, which might correspond to the second episode identified at the Meishan section (Xie *et al*, 2007). However, the corresponding $\delta^{13}C_{org}$ shows a distinct positive shift from ~-28‰ to ~-25‰. During the extinction interval, the $\delta^{13}C_{carb}$ increased to ~1‰, and the $\delta^{13}C_{org}$ kept relatively constant.

In addition to the two episodes of general negative shifts, it is interesting to note that there are two intervals characterized by sharp negative shifts in $\delta^{13}C_{carb}$. One of them was found to occur around the P-Tr boundary, in which the $\delta^{13}C_{carb}$ declined from +1‰ to -1.3‰ within 3-cm thick strata. On the basis of recent high-resolution dating (Shen *et al*, 2011), this shift produces a variation rate as high as 80‰/Ma for the $\delta^{13}C_{carb}$, suggesting the occurrence of huge methane release.

Our data in Ganxi section indicate that the significant negative shifts in $\delta^{13}C_{carb}$ and $\delta^{13}C_{org}$ were not caused by the mass extinction. Episodic release of methane, combining with other events, might have occurred during the mass extinction interval, which could make a contribution to the extinction and environmental perturbation.

[1] Berner (2002) *Proc Nat Acad Sci USA* 99, 4172-4177. [2] Chen & Benton (2012) *Nature Geoscience* 5, 375-383. [3] Erwin et al (2002). *Boulder Geol. Soc. Amer.* 356, 363-384. [4] Shen *et al* (2011) *Science* 334. [4] Xie (2007). *Geology* 35, 1083-1086.

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