Petrogenisis of a plume-related layered cumulate complex in the Northwest Yangzi Craton: Petrological and geochemical constraints

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A striking feature of the Yangtze Craton is that strongly magmatic activities occurred almost simultaneously in the Neoproterozoic times (ca. 820~830 Ma); some suggested result from a mantle super-plume activity at the age of ca. 825 Ma, which has led to breakup of the Rodinia supercontinent [1, 2], and others argued an island arc environment based on depletion of high field strength elements (HFSEs) in the Hannan layered intrusions [3].

The Hannan layered cumulate intrusion occupies an area of ~ 800 km^2 and is the largest intrusion and within the Northern Yangzi Craton. Dating of zircon gave a magmatic age of 819 ± 10 Ma [3]. This layered intrusion can be divided into four rock units, from the bottom to the top, (1) Troctolite unit, (2) Leuco-gabbro unit, (3) Gabbro + Fe-Ti-V oxide ore unit and (4) amphibole-gabbro + diorite unit. Mg-numbers decrease with increasing of SiO_2-contents from the bottom to the top. Troctolite layers steadily occur in the lower part of the layered intrusion, reflecting that the parental magma generates in a "dry" environment rather than the "wet" island arc. The negative anomaly of Zr and Hf in troctolite and leuco-gabbro from units (1) and (2) can be readily explained as excessive cumulation of plagioclase, because K_D of Zr and Hf between plagioclase and melt is much lower than that between pyroxene and melt. Ilmenite exsolution lamellae in plagioclase suggest that minerals crystallized from a high-T and Ti-rich parental magma. Combining all aspects of fact, for instance, the LREE-enriched patterns of all rocks, the E-MORB-affinity trace element spidergram of rocks from the high-level of the intrusion, and thick layers of vanadium-bearing titanic magnetite ore deposit, we therefore inferr that Hannan complex crystallizes from a high-temperature magma at an environment of mantle plume.

[1] Li *et al.* (1999) *Precambrian Res.* **97**, 43-57. [2] Li *et al.* (2003) *Precambrian Res.* **122**, 85-109. [3] Zhou *et al.* (2002) *Earth Planet. Sci.Lett.* **196**, 51–67.

Gas vents through pockmarks and its effect on gas hydrate stability below seafloor

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Precipitation of gas hydrates decreases the permeability of the sediment and even blocks the upward migration of fluids. The pore-pressure will build up and this will cause a decrease in the shear strength of the hydrate-containing sediments. The failure of the hydrate containing layer can be analyzed with the Mohr-Coulomb criterion and the hydraulic fracture. Once the sediment has been fractured or even be fluidized, gas escape is triggered. The seeping gases penetrate the hydrate seal and the sediment column above, and eventually a fluid path of considerably high permeability and a hollow pockmark is formed.

The pockmark height equals approximately half of the thickness of interconnected gas column trapped by hydrate. Along the escape route free gas and seawater coexist and the density of this mixture is smaller than that of seawater ($\rho_f < \rho_{sw}$), and thus the pressure exerted on the gas hydrate becomes smaller ($P = \rho_f gh + \rho_{sw} gD$).The gas hydrate at the base of the hydrate stability zone (BHSZ) will dissociate as the BHSZ shifts upward because of the decrease of the pressure. The methane released from the gas hydrate migrates into the fluid path and makes the seeping fluid lighter, which aggravates the dissociation of the gas hydrate and the upward shift of the BHSZ (Fig.1). Presume that a 100-meter-thick gas hydrate already exists at the BHSZ (Fig.1). When the fluid density decreases to 0.535ρ_{sw} the depth of BHSZ will shift from 474mbsf to 374mbsf and the former gas hydrate will decompose completely.

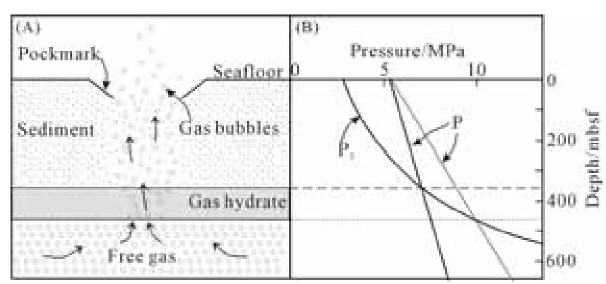

Figure 1: Effect of gas seeping on gas hydrate stability. (a) The schematic plot of free gas venting through gas hydrate layer and the pockmark formation. (b) The base of hydrate stability zone shifts upward and gas hydrate at the BHSZ dissociates due the density decrease of seeping fluid. The water depth is 540m and the density of the seawater is 1025Kg/m^3.