Shungites and Fullerenes: Implications for Redox Evolution during Shunga Event

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Following Great Oxidation Event (GOE) at ~ 2.32 Ga, the Paleoproterozoic period witnessed return of reducing conditions at ~ 1.9 Ga as indicated by the presence of Granular Iron Formations (GIFs) [1] and also as suggested by the redox trace element concentrations in black shales. Contrary to this, it is suggested oxidative weathering was initiated at this period as indicated by the negative excursions in carbonate and organic fractions during this same period coupled with enrichment of Uranium referred to as Shunga-Fracevillian Event [2]. The Shungites of Jatulian sequences of ~ 1.9 Ga known as the earliest occurrence of organic burial event of the geological history are also significant for the presence of natural fullerenes [3]. In this work we present the evidence for the occurrence of fullerenes restricted only to the lustrous portions of shungites. The non-lustrous portions of shungites contain poly-aromatic hydrocarbons. The maturation was sufficient to synthesize naturally occurring fullerene molecules in the lustrous veins. We suggest here that the lustrous shungite veinlets are probably a result of remobilization during low grade (green schist facies) metamorphism that affected these carbonaceous sediments.

The Carbon isotope data ($\delta^{13}C$) of shungites ranging from -44 to -26 ‰ V-PDB [4] indicate that the carbon is mostly organic in nature. The lustrous portions do not show any significant deviations from the average reported $\delta^{13}C$ values of other varieties of shungites. The $\delta^{34}S$ values of the sulfides associated with these carbonaceous sediments show a large range from -22 to +32 ‰ V-CDT and most of the values are being on the positive side indicating a closed basinal depositional conditions. Interestingly, the sulfides from the carbonaceous strata of the Mangampeta fromation, Cuddapah Supergroup, India that bear natural fullerenes suggest similar conditions for the paragenesis of natural fullerenes.

[1] Rasmussen, B. et al. (2012) Nature 484, 498.
[2] Kump, L.R. et al. (2011) Science 334,1694.
[3] Parthasarathy, G. et al., (1998) GCA 62, 3541.
[4] Melezhik, V.A. et al. (1999) Earth Sci. Rev. 47, 1.