

Buried nodules from the Central Indian Ocean Basin

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Abstract

The occurrence of buried nodules is rare compared to surface nodule abundance in the deep sea. Surface nodules are collected with freefall grab, vanveen /peterson grabs, dredges and sediment cores whereas buried nodules with exact depth are recovered only by sediment cores. Despite, the slower growth rates of nodules (few mm/Ma) compared to associated sediment (few mm/ka), the phenomena of keeping nodules at the sediment surface still remains an enigma.

More than 60 sediment cores (spade and gravity) were collected from the Central Indian Ocean Basin to understand the source of elements and paleoclimatic studies. Twelve sediment cores showed presence of buried nodules at different depths and water depth in these cores varies from 4740 to 5800 m. Maximum of 15 buried nodules were recovered in one core (AAS-22/ GC-07) and maximum depth where buried nodule recovered is at 5.35 m depth below seafloor. In the present study a total of twenty buried nodules from four sediment cores were utilized. Of these, 13 buried nodules are from two sediment cores in siliceous ooze and seven from two sediment cores in a red clay area. Here, we have studied morphology, size, surface texture and chemical composition of buried nodules from two different sediment type.

The buried nodules are elliptical, elongated, rounded, sub rounded, irregular and polynucleated . Majority of these nodules are ~ 2 cm in diameter and have both smooth and rough surface texture. Manganese and Fe content of nodules from siliceous ooze varies from 18.7 to 29.1%; 1.73 to 14.1% whereas from the red clay they range from 17.4 to 20.9 % and 8.1 to 11.1% respectively. The Mn/Fe ratio suggests that nodules from siliceous ooze are hydrogenous, diagenetic and early diagenetic in nature where as nodules from red clay area are formed by only hydrogenetic process. Nickel is more enriched compared to Cu in the buried nodules. The factors responsible for the elemental variations and genesis of these buried nodules are discussed.

During the last two decades, National Institute of Oceanography Goa, Under Department of Ocean development has carried out considerable amount of research on polymetallic /ferromanganese nodules from Central Indian Ocean Basin (CIOB). Ferromanganese nodules occur as a thick carpet on the seafloor. Their abundance varies from traces to 20 kg/m². Surface nodules from the seafloor are recovered with free fall/ VanVeen/ Peterson grab, dredges and sediment cores, whereas subsurface or buried nodules are collected with their exact depth only by sediment cores. Compared to surface nodules buried nodules were received less attention in the CIOB may be due to their occurrence at depths. Ferromanganese nodules generally grow at the sediment –water interface despite the slower growth rates (few mm/Ma) than the accumulation rates of associated sediment (few mm/Ka). The possible mechanism for retaining the nodules at the sediment surface could be due to reworking of sediment by benthic organisms (Glasby et al., 1982). Alternatively, due to small density difference between the nodules (1.96 g/cm³) and associated sediment (1.33 g/cm³) only a small upward force is enough to maintain at the sediment –water interface (von Stackleberg, 1984) . The nodules that are left behind during uplift are kept buried in the sediment. Usui and Ito (1994) suggested that when the sedimentation rate is greater than 5 m/Ma that time nodules get buried. In the present study, we have collected buried nodules at different depths in a sediment cores from siliceous and red clay area are compared with the surface nodules from the respective sediment type.

During Polymetallic Nodules Exploration program more than 60 sediment cores of varying depth were collected (Fig.1).

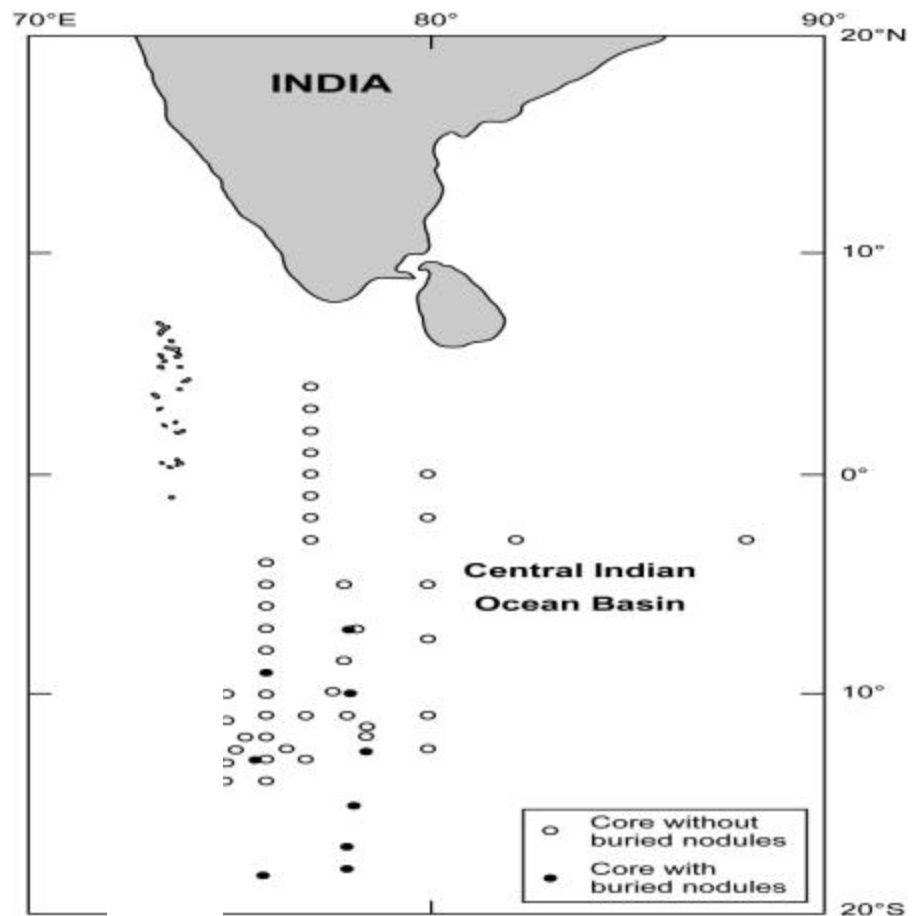


Fig. 1. Location of sediment cores in the Central Indian Ocean basin.

From Fig.1 it is observed that buried nodules were recovered only 8° S onwards and in particular they are more abundant comparatively between 12° to 18° S. Out of

60 sediment cores only 12 cores showed presence of buried nodules at different depths. Out of 12 sediment cores, 10 are from siliceous and two from red clay area where buried nodules have been recovered. Depth wise distribution of buried nodules in all the 12 sediment cores is shown in Fig.2.

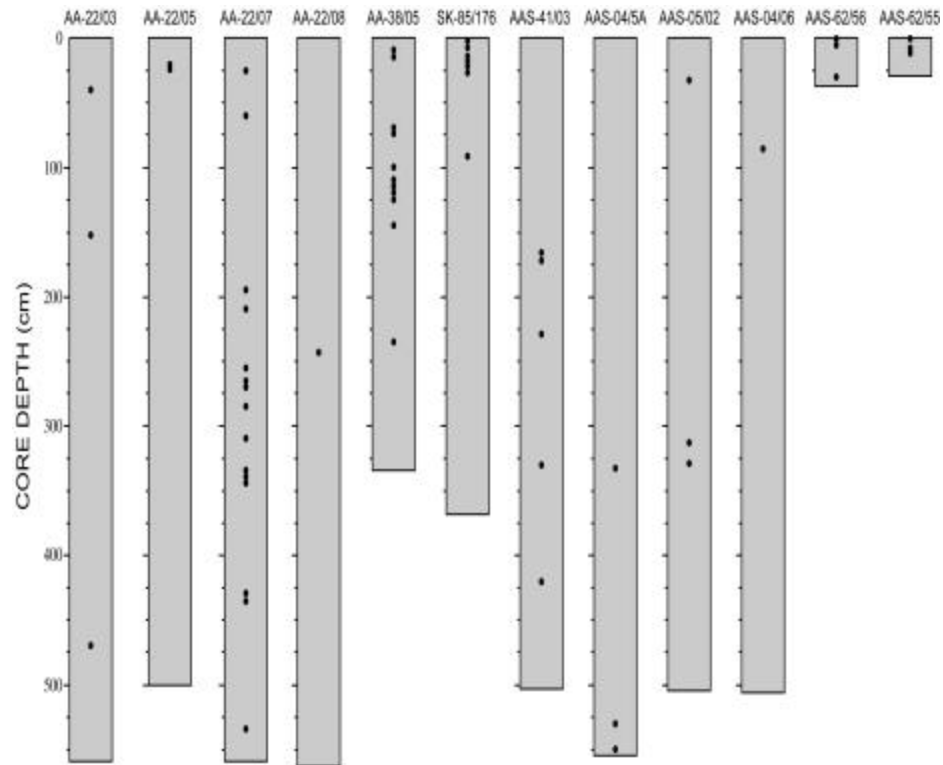


Fig.2. Occurrence of buried nodules at different depths in sediment cores from CIOB.

Maximum of 15 buried nodules were recovered in one sediment core (AAS-22/GC-07). The maximum depth of occurrence of buried nodule in the present study is 5.35 m below the seafloor.

The size of surface nodules from CIOB varies from less than 1 cm to 12 cm in diameter. The common most size is 2-4 cm in diameter. The size of buried nodules is mostly ~ 2 cm in diameter. This suggests that larger size nodules are not undergoing any burial process. The buried nodules also exhibit rough and smooth surface texture similar to surface nodules. Similarly their morphology such as elliptical, elongated, rounded, sub rounded, irregular and polynucleated which are also similar to surface nodules.

The chemical composition of buried nodules from siliceous and red clay area are compared with surface nodules from their respective sediment type are presented in Table 1 and 2 respectively..

Table:1 Average concentration of transition elements (%) in the surface and buried nodules from siliceous ooze of CIOB

Element	Surface nodules #	Buried nodules @
Mn	27.34	24.57
Fe	5.06	8.08
Co	0.11	0.128
Ni	1.05	0.87
Cu	1.00	0.87
Mn/Fe	5.40	3.04

- Jauhari (1990). N=31

@ - Present study. N = 13

Table.2: Average concentration of transition elements (%) in the surface and buried nodules from red clay area of CIOB.

Element	Surface nodules #	Buried nodules @
Mn	21.58	19.11
Fe	8.39	9.54
Co	0.175	0.187
Ni	0.71	0.79
Cu	0.53	0.41
Mn/Fe	2.57	2.00

- Jauhari (1990). N=31

@ - Present study. N = 7

Buried nodules from siliceous ooze are rich in Mn (24.57%), Cu (0.87%) and Ni (0.87%) content (Table.1) are almost similar to surface nodules (Jauhari, 1990). The Mn/Fe ratio of these nodules suggest their formation by hydrogenetic, diagenetic and early diagenetic processes. The high content of Mn, Cu and Ni in these nodules could be due to supply of metals by diagenesis from under laying sediment through pore water. Buried nodules from red clay area are rich in Fe (9.54%) and Co (0.187 %) compared to siliceous nodules. The Mn/Fe ratio (2.0) of these nodules suggests their formation only by hydrogenetic process where metals are supplied by the water column. The similar chemical composition of buried and surface nodules from both siliceous and red clay area in CIOB may suggest that buried nodules stop growing once they are buried in the sediment column.

References

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