# Boron content in the shales of the Arangi Formation

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## Abstract

A comparison of the boron/illite ratio of the shales of Arangi Formation with the clays and shales of known environments indicates that the former have originated from non-marine, brackish and marine saline-waters. Gradually the level of salinity seems to have increased with time.

## Introduction

The basal member of the Semri Group in the Dala-Obra area of the Mirzapur district is known as Arangi Formation which contains basal conglomerate and shales. It is overlain by the Kajrahat-carbonate sequence. The present investigation provides information on the boron content and salinity of the shales.

A set of samples representing different mineral modes has been analysed in triplicate by the emission spectral analytical methods. Beryllium has been used as an internal standard, and to check the accuracy, several international standards have been analysed (Table I). The boron content in clays of different salinity waters varies according to the boron content in the solution. This has led workers to use it as a salinity indicator. The samples analysed here are free of tourmaline and are fine grained. The boron concentration in the samples is dependent upon the proportion of the clay minerals present. Therefore, the quantitative determination of clay minerals has been done with the help of infrared spectroscopy and X-ray diffraction.

TABLE I. Illite and boron content in the shale of Arangi Formation (Vindhyans) and Upper Carboniferous of Western Germany (+).

| Sample No. | Illite % | B ppm | B ppm/ % Illite |
|---|---|---|---|
| VSHK 1 | 50 | 150 | 3 |
| VSHK 2 | 45 | 120 | 3 |
| VSHK 3 | 35 | 230 | 6 |
| 648+ | | 145 | |
| 655+ | | 130 | |
| 663+ | | 130 | |
| 667+ | | 70 | |
| 672+ | | 80 | |

*Note:* The mineral determinations are ± 5%.
Standard ZGI–TB contains 82 ppm B.

## Boron in the samples

Amongst the constituent minerals, illite is the main component which contains boron. Therefore, boron/illite ratio is the main criterion which has been used in the evaluation of boron data of the Vindhyan rocks. The samples analysed in this work represent variation in illite, chlorite and quartz percentage of rocks. They are fine grained rocks with no trace of tourmaline and muscovite. The sample VSHK-1 is rich in pyrite and is of sapropel environment. From sample 1 to 3 quartz increases, illite and chlorite decrease. Sample VSHK-3 is a calcareous shale. Five samples of definite marine and non-marine environments from the Upper Carboniferous of West Germany have been analysed for comparison (Table I). They suggest that more than 100 ppm boron in the shales is of marine environment, whereas 75 ppm boron is of brackish waters. Fresh water shales are much lower in boron content. Wedepohl (1969) has determined boron content in the marine Kupferschiefer of Western Germany and his data indicate the boron/illite (%) ratio as 4. The data given by Harder (1959) suggest this ratio as 1 for fresh water illite, 2 for brackish and 4 for marine illite of normal salinity.

The samples of the Arangi Formation are of non-marine to marine conditions so far as the salinity level is concerned. It seems that there had been intermittent mixing of marine and non-marine waters which has caused different salinity levels. The calcareous shales have formed in nearly fresh to brackish water conditions. The arenaceous shales of this sequence record higher salinity conditions coupled with increased detritus and evaporation. The latter observation indicates that the boron content has increased at times due to higher influx of detritus. It is clear that these rocks have been deposited in a basin where the salinity level was changing.

## Conclusion

The lower and higher levels of boron in the shales of the Arangi Formation are a guide to the fluctuations in the concentration of this element during the deposition of these sediments. To account for such fluctuations different models have to be visualised. If these sediments were deposited in an intertidal zone in the proximity of a major sea, then the lowermost boron content would have been less than the normal marine shales. Similarly in a supratidal region the lower boron content will be controlled by the tidal waters (marine) while higher boron will depend upon evaporation. If the source area is rich in boron then it is very likely that with evaporation illite with higher boron content may result. Several experiments (Harder, 1961; Fleet, 1965) have demonstrated an irreversible incorporation of boron in illite; therefore, to consider that the boron content in illite is a result of pre-depositional environment and it could not change at the site of deposition (i.e., in marine waters) would not be logical. In a very special case, if the source of sediments are ultramafic rocks or andesites (containing on an average 7 ppm B and 22 ppm B respectively; data from Wedepohl, 1969 & 1974) then higher boron can be expected in surface waters. In such an environment the sediments deposited in shallow basins would produce Arangi Formation type sediments. The latter model supported by abnormally high concentration of Mo and Co (i. e., greater by a factor more than 10 than the average of these elements in shales) in these sediments indicate their probable ultramafic provenance.

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### References

FLEET, M. E. L.. (1965) Preliminary investigations into the sorption of boron by clay minerals. *Clay Minerals*, v. 6, p. 3.

HARDER, H., (1959) Beitrag zur Geochemie des Bors. Teile I, II Bor in Mineralen, Bor in Sedimenten. *Nachr. Akad. Wiss. Göttingen, II. Math.-Phys. Kl.*, v. 5, p. 67 and v. 6, p. 123.

—— (1961) Einbau von Bor in detrische Tonminerale, Experimente zur Erklärung des Borgehaltes toniger Sedimente. *Geochim. Cosmochim. Acta*, v. 21, p. 284.

WEDEPOHL, K. H., (1969) Untersuchungen am Kupferschiefer in Nordwestdeutschland; ein Beitrag zur Deutung der Genese bituminöser Sedimente. *Geochim. Cosmochim. Acta*, v. 28, p. 305.

—— (1974) *Hand Book of Geochemistry*, Volume I, II/1-4. Springer Verlag, Berlin, Heidelberg, New York.

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