

Phosphate induced Fluorosis a Global Geohealth Issue

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Abstract

High concentration of fluoride in the groundwater is observed to be associated with granitic aquifers as well as near phosphate mines around the globe. The present work is a hydrogeological study of the ground water of Beldih phosphate mines in India. Being located in the Singhbhum shear zone the area has a complex tectonic history and is dominated by phosphate, alkali granites, amphibolites, and granitic gneiss with higher abundance of fluoride bearing minerals like apatite and biotite. Total of 12 water samples were collected for a preliminary study to assess the spatial variation of fluoride in ground water and surface water with an aim to understand the effect of phosphate mines in elevating fluorosis in adjoining areas. The groundwater chemistry shows a trend that the concentration of fluoride and nitrate gets elevated as we approach towards the open cast phosphate mines. From the spatial observation combined with the water chemistry and geology it is evident that the apatite dissolution is the prime cause of the elevation in fluoride concentration. However presence of iron in the lithology controls the fluoride level to some extent. Since the area is effected with high fluorosis its can be concluded that the groundwater geochemistry along with the air borne fluoride present in the phosphate dust are the major cause of the fluorosis. The exploration of phosphate must be carried out with out most environmental care and the mitigation of post mining effect should be planned before mining operation. Fluorosis is an irreparable health hazard and a major geohealth concern that has already affected a large amount of population.

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Introduction

Phosphate mining effect the hydrogeology of the area in different ways like the area generally shows reduced runoff coefficient and runoff peak (1). Elevated fluoride levels in the groundwater has been observed in the vicinity of phosphate mines. The occurrences of fluorosis in the livestock around the plateau area of Beni Mesquine, Morocco (2) is a well documented case study showing the buffering of phosphate rocks in elevating the groundwater fluoride. The dust particles arising due to phosphate mining contains high amount of fluoride that can effect the human health (Fig. 1). However this area of study is least investigated.

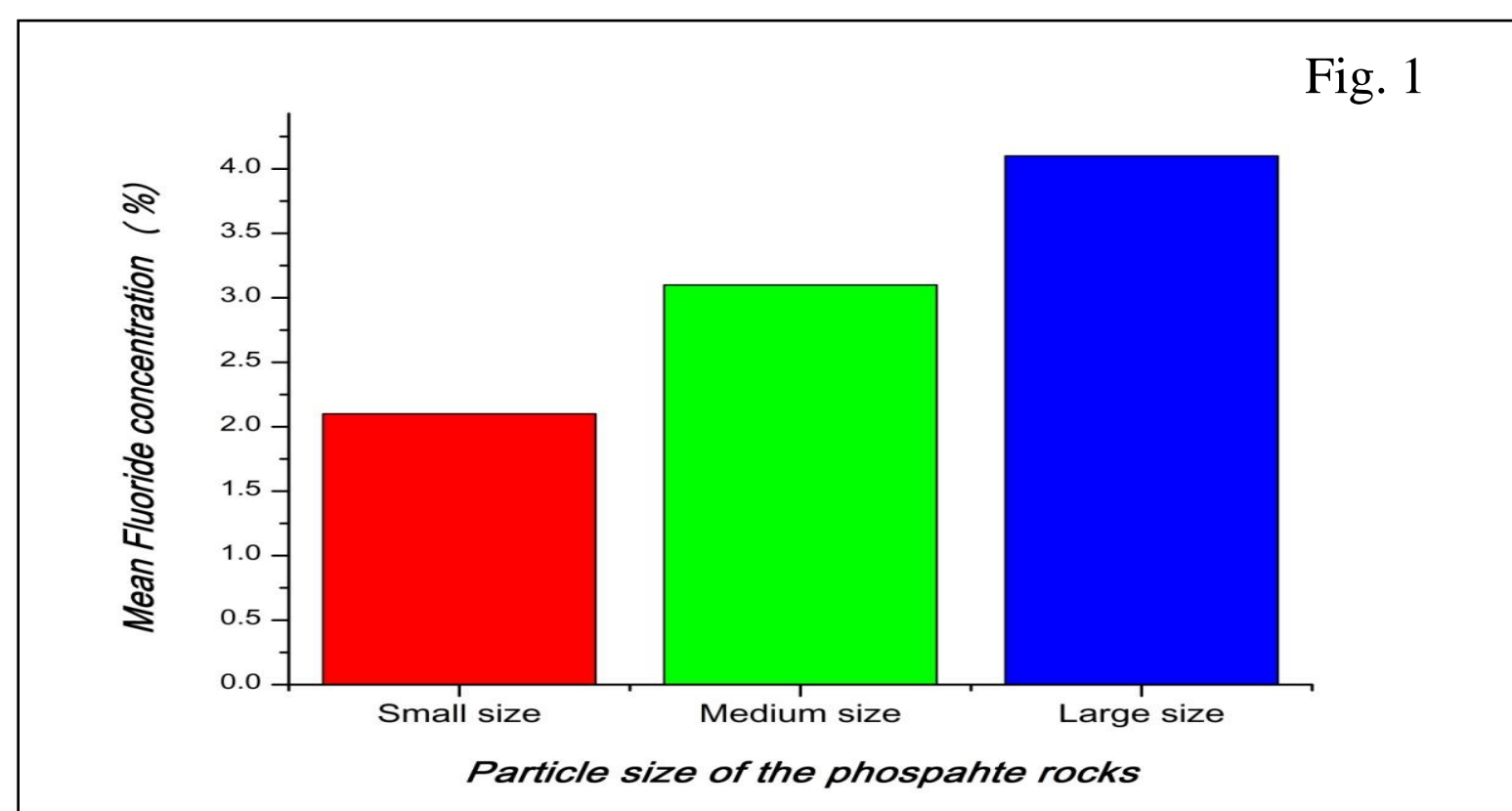


Fig 1: Fluoride in Phosphate dust particles . The different size of the dust particles contain different amount of fluoride concentration (2)

Mineralogy

The major mineral in phosphate mines is Apatite and its has high percentage of fluoride. The dissolution of fluoride from Apatite is also high and hence its enhances the concentration of fluoride in ground water.

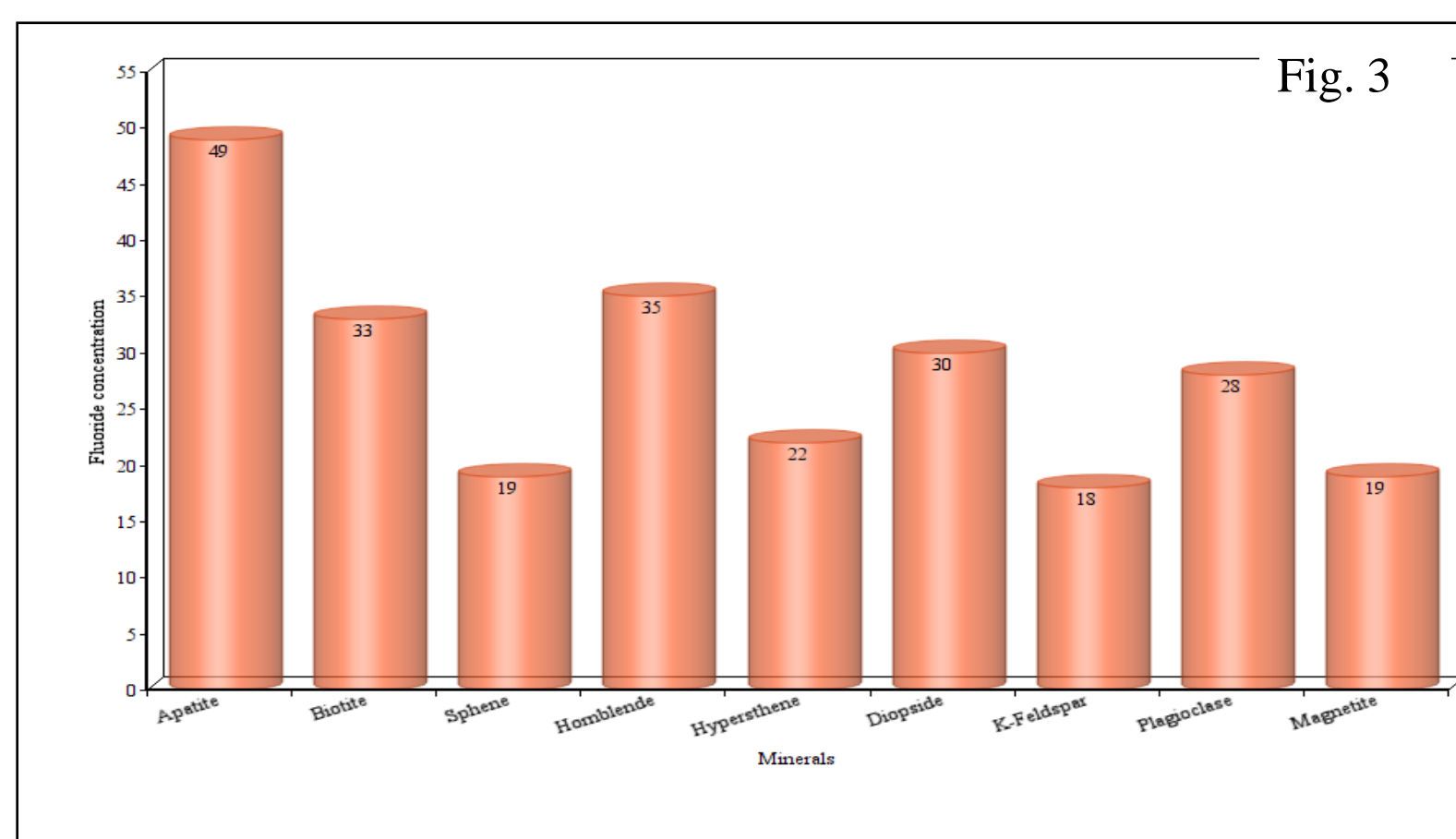


Fig 3: High concentration of fluoride in Apatite(4)

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Geochemistry and Mechanism

A positive correlation is observed between fluoride and phosphorus around the phosphate mines. Near the vicinity of phosphate mines the fluoride concentration increases with the decrease in distance from the phosphate mines. The water chemistry will reveal this fact clearly (Fig. 2). In the present work as we approach towards the phosphate mines the fluoride concentration increases (Fig. 4).

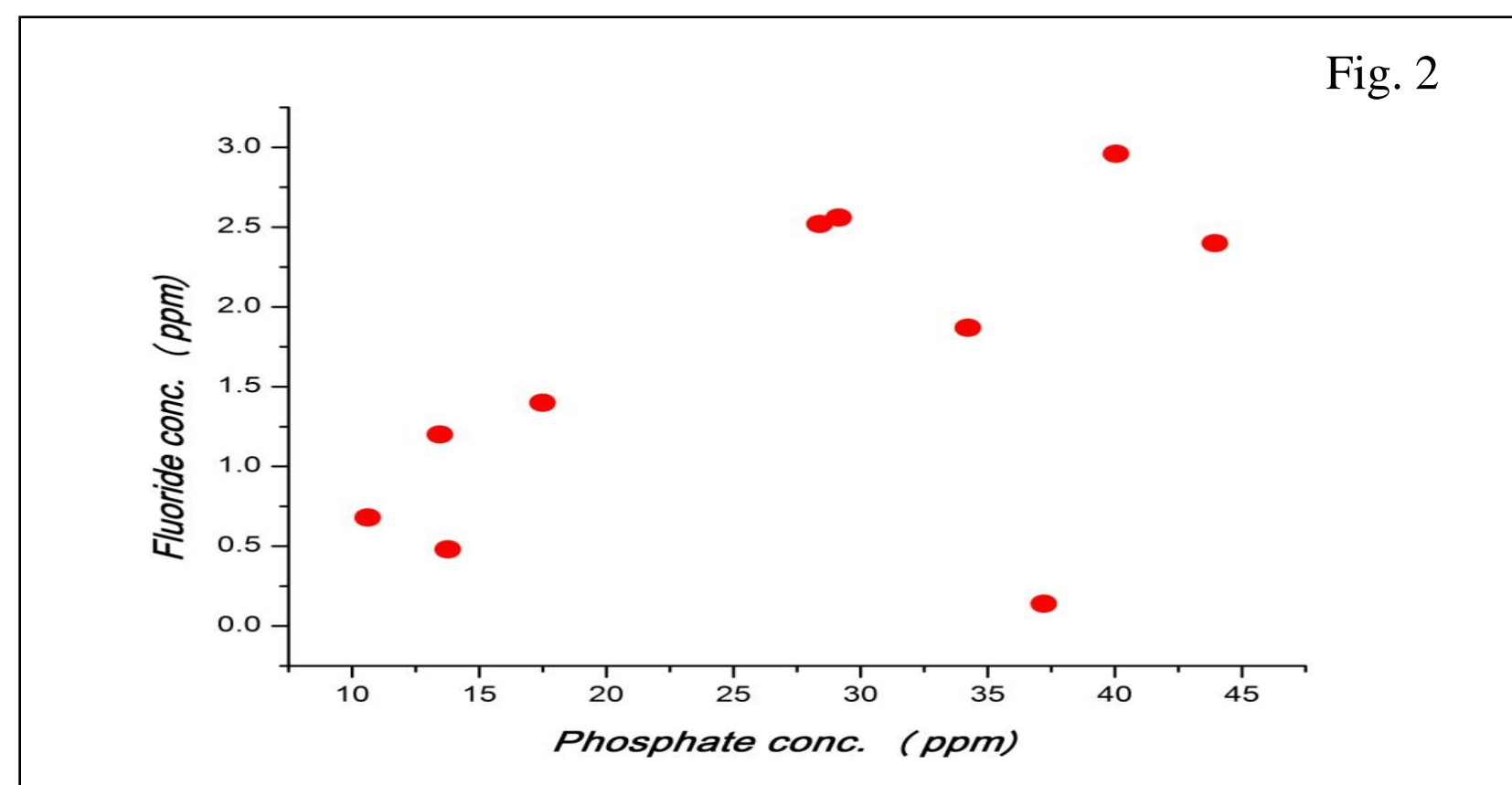


Fig 2: Positive correlation of fluoride in water with phosphorus (3)

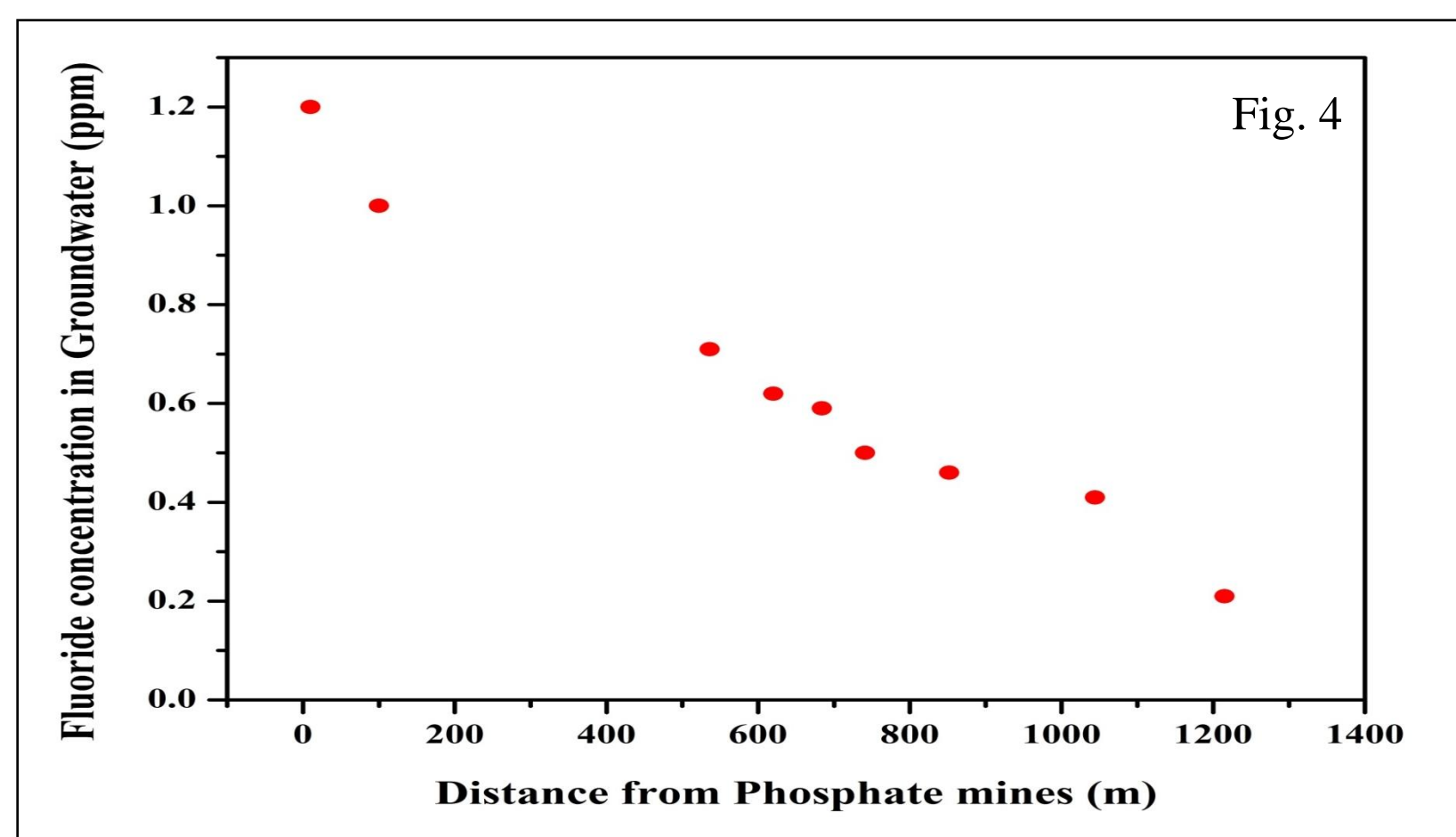


Fig 4: Positive correlation of fluoride in water with decreasing distance from phosphate mines

Conclusion

1. High fluoride concentration in groundwater near the phosphate mines is controlled by the fluoride content in Apatite (Fig. 4) .
2. The water geochemistry and presence of fluoride in Apatite suggest that the dissolution of fluoride from phosphate rock is high and large (Fig. 2, Fig.3).
3. The dust particles in the air near the phosphate mines have high fluoride concentration and causes skeletal fluorosis (Fig. 1).