THE AGE OF THE DIAMOND-BEARING ROCKS OF PANNA, MADHYA PRADESH

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DIAMOND source rocks are those rocks in which diamonds are found and to which the diamonds are genetically related, or "roche mere" as the French aptly call them. Diamond host rocks are sedimentary rocks containing diamonds but the diamonds were at some time detrital minerals.

Diamond source rocks are of three ages: (1) Around 100 million years, the kimberlites, which range from Upper Jurassic in Siberia, to Cretaceous for the most part, with some postulated as Early Tertiary. (2) Proterozooic, or Upper Precambrian, as at Panna, and possibly in the Diamantina area, Brazil. (3) Older than 2,000 m.y., as is evidenced by host rocks in many countries, *e.g.*, the Witwatersrand, South Africa and the Birrimian, Ghana; no source rocks of this age are yet known. Whether there are more than three ages is not known, perhaps there are not.

The Majhgawan pipe, near Panna, and, by inference, the adjacent smaller Hinota Pipe, are the only dated Proterozooic diamond pipes in the world. It is one of the objects of this paper to examine the bases for this dating.

Taking the last evidence first: Professor J. F. Lovering[1] has dated the phlogopite from Majhgawan as 1130 ± 20 million years by the Rb/Sr method at the Australian National University, Canberra. This phlogopite occurs only in certain facies of the pipe as rounded lumps, up to 1 cm. diameter; a few phlogopite flakes occur in other facies. The intrusion is clearly composite. One might surmise that the phlogopite lumps are xenocrysts; much has been written but there is, as yet, no accepted concensus of opinion on the genesis of kimberlite.

Accepting the date of the phlogopite as correct, what is the date of intrusion of the pipe? In some Siberian kimberlite pipes the phlogopite has been dated as 661 m.y. (average)[2] yet by stratigraphical evidence the pipes were definitely intruded into post-Upper Jurassic strata, say 140 m.y. There was thus a time-lag of 500 m.y. between the crystallisation and the intrusion. Were we to deduct 500 m.y. from the 1,130 m.y. of the Panna phlogopite, the date might be around 630 m.y., still just Precambrian.

Thus to attempt to date the Lower Vindhyan—the Panna pipe is intruded into Kaimur sandstone (= Dhandraul Quartzite)—by the pipe is precarious. The stratigraphic dating of the Vindhyan is still uncertain. That it contains stromatolith-like fossils, could, by comparison with African formations, take it back almost 2,000 m.y. If, in fact, uppermost Vindhyan runs up to the Palæozoic, that is not much help either; there may be long nonsequences. African experience has shown that most formations, when eventually dated, were far older than supposed.

Before the radioactive dating was received, several other lines of evidence had been considered and these are still worth setting down. The balance of evidence is in favour of the Majhgawan pipes being of Lower Rewa Sandstone (= Itwa Quartzite) age, pene-contemporaneous with the diamondiferous conglomerates in that formation.

In the writer's opinion the strongest evidence is the similarity of the diamonds in the pipe and in the conglomerates. The general type is the same and almost unique in the world. There are minor—and important—differences within this general type, from place to place, but the similarities are more striking. This implies that the diamonds are all derived from pipes of a similar type and of the same general age. He does not believe that the Majhgawan pipe fed any of the known conglomerates.

The main pipe is now exposed only a few feet below the original surface of the Kaimur Sandstone. Parts of the pipe rock are vesicular, and much of it has a glassy base. The Cretaceous land surface in this area would have been 250 metres, perhaps 300 m., higher than the present surface. It seems unlikely that a volcanic rock would be vesicular to such a depth; in other words, the vesicular nature suggests that the present surface is not far below the surface through which the pipe originally burst.

Some of the pipe rock seems to be consolidated ash; this again suggests that the present surface is not far from the original surface. (This deduction may be challenged on the grounds that ashy beds are found in the crater of the Williamson kimberlite pipe, Mwadui, Tanganyika, to a depth of 200 metres, but these are ashy lake beds laid down in the original crater lake.)

In several of the pits put down by the G.S.I. and in at least one put down by the N.M.D.C., shales were found which closely resemble the Jhiri shales exposed in the vicinity. In the G.S.I. pitting shales were found down to 12 metres below the surface. The exact type of junction between the shales and the pipe-rock and between the shales and the sandstone is still not clear, whether the shales are welded on to the sandstone walls, whether the junction is sheared, or whether the shales do not meet the walls. In one case Mathur says the junction between the shales and the pipe-rock was sharp but irregular; in another the mixture was crumpled and sheared on the small scale; the shales were shattered; sub-angular and sub-rounded blocks were mixed with blocks of siliceous material.

There are three possible mechanisms by which shales could occur in the pipe, below the level of the surface of the surrounding Kaimur Sandstone. First: there was an open explosion crater on dry land in the Kaimur surface; when the sea next invaded that area it started depositing the muds, which became shales, in the crater. Further east Mathur has observed an area of Jhiri shale, well to the north of the present main outcrop, which was due to a depression in the Kaimur floor. This would mean that the first explosion was post-Kaimur, pre-Jhiri.

Second: The shales may be "rafts" or "horses", *i.e.*, large xenoliths. In kimberlite pipes, small or immense blocks of sedimentary rock from a higher level have dropped deep into the kimberlite pipe. (The Premier Mine is the classic example.) This would imply that the pipe was later than at least part of the Jhiri shales.

Third: When a kimberlite pipe is altered by serpentinisation there is an increase in its volume; the plug of kimberlite pushes up in the pipe. This pipe-rock is not a kimberlite; its alteration is extreme; perhaps it may have sunk, rather than pushed up, and let down into the pipe area Jhiri shales which had been deposited subsequently to the pipe formation.

The writer has put forward the suggestion that the Panna shales, which die out in Shahidan as far as the present information goes, reappear further west, and that the shales in the pipe are of Panna and not Jhiri age. He does not put much weight on this suggestion.

What interpretation is to be put on the existence of shales in the pipe is by no means clear; but whichever hypothesis is adopted it does not imply that the pipe intrusion was necessarily later than an early stage of the Jhiri shales.

In the sedimentary beds to the east various members of the Lower Rewa series have been found which incorporate volcanic ash. The highest ashy bed so far found is in Jhiri shales 12 metres up from the top of the Lower Rewa Sandstone. This proves that there was volcanicity of a sort, and apparently of the same sort, of this age.

Summarising the above: The Majhgawan pipe is definitely younger than the Kaimur Sandstone. The evidence strongly suggests that it is approximately of Lower Rewa Sandstone age, the same as the conglomerates, but possibly as young as Lower Jhiri age. Nothing suggests it is younger.

Readers will have noticed above that the Majhgawan pipe-rock has not been called a kimberlite; the writer does not like calling it that, despite the fact that it is an ultrabasic rock, of somewhat similar composition to kimberlite, carrying diamonds. Kimberlites are so diverse that it is difficult to define them. Petrographically the main differences are that parts of the Majhgawan rock are vesicular and most of it has a glassy base (now entirely decomposed). How far the absence of the typical kimberlite minerals, pyrope garnet and magnesian ilmenite, can be invoked, is difficult to say. They could have decomposed in the length of time since the Precambrian. Minute grains of pyrope have been found, but only by crushing, panning and treating in bromoform several kilograms of rock. These minerals do not appear in ordinary pan or gravitation concentrates.

Although the chemical analyses of the pipe-rock do fall within the range of kimberlites, there are significant differences; magnesia is very low, titania is high and alkalis are almost absent.

It is hoped that S. M. Mathur will be publishing a petrological paper during the course of this year, so we will not anticipate. The author would like to express his appreciation of the excellent work done by Mathur at Panna and of the help received from him.

No mention has been made of the diamondiferous conglomerates in the Upper Rewa Sandstone. No one knows anything about the origin of these diamonds.

APPENDIX

An Ashy Sediment

Bilkhura N.M.D.C. Pit No. 7.

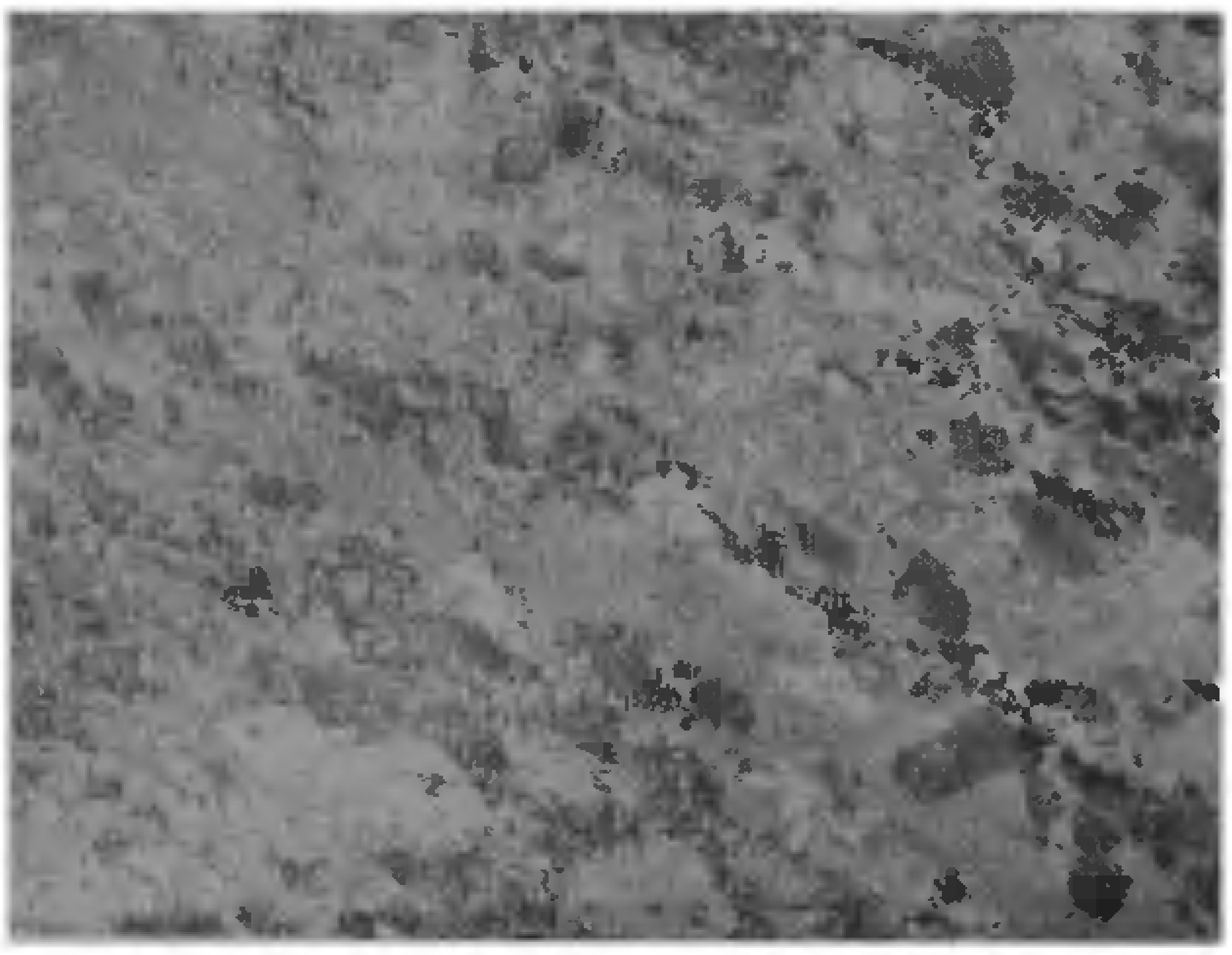

FIG. 1. Carbonated ashy sediment, Bilkhura Pit No. 7, × 10·8.

The rounded areas appearing dark gray in the photograph are pale brown with green spots; these are volcanic ash pellets, carbonated. The pale gray band diagonally across the lower centre of the photograph and in the top left corner, and much elsewhere, is finely granular carbonate. The black spots are limonite and hæmatite, probably derived from siderite. The white areas are quartz.

Specimen found in excavated material on surface. A green sandy layer, spotty with occasional 5 cm. rounded, flat pebbles. Calcite in layers and in cracks.

Composed of grains, ½ to 1 mm. mostly oval, some irregular elongated, of fine-grained material, greenish-brown (slightly weathered) to green-gray. These are set in a matrix of heterogeneous fine-grained carbonate, with a little quartz and a fair amount of limonite.

The grains (or pellets) are composed of extremely fine-grained granular carbonate, but under crossed nicols seen to be arranged in patches. Amongst this is a small amount of equally fine-grained chloritic material. Larger flakes of green chloritic material are frequent. Sometimes the chloritic material is marginal, almost a complete rim.

It is believed that these grains are volcanic ash, very small lapilli. The larger chlorite flakes may represent original phenocrysts. The glassy volcanic base has been carbonated and some of the ferromagnesian content pushed out as a rim.

The carbonate base is most curious; every grain has a spot in the centre. (It looks just like onion skin; every cell having a nucleus.) There is no evidence whether this is a carbonisation of ash or shale.

Much of the limonite is arranged in irregular lines; some forms a margin to pellets; it represents previous siderite.

A few of the quartz grains are sand grains; most are in local mosaics or layers; some are probably secondary.

The rock is carbonated volcanic ash.

1. Lovering, J. F., Personal communication.
2. Mikhoyenko, V. I. and Nenashev, N. I., "Absolute age of formation and relative age of intrusion of kimberlites of Yakutia," *Trans. H. Faul, Internat. Geol. Review*, Vol. 4, No. 8.
3. Mathur, S. M., Geological Survey of India, Numerous papers published and unpublished.

IDENTIFICATION OF CHROMOSOMES CARRYING THE MAJOR GENES FOR DWARFING IN THE WHEAT VARIETIES LERMA ROJO AND SONORA 64

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LERMA ROJO and Sonora 64 are two semi-dwarf wheat varieties developed in Mexico by Dr. N. E. Borlaug and his colleagues, the donors of the dwarf character in them being the Japanese Norin wheats. Dwarfing in Norin wheats apparently owes its origin to spontaneous mutations in the cross Fultz-Daruma × Turkey Red.[1]

At Delhi, Lerma Rojo grows to a height of 90 cm. (mean height 91·30 ± 0·60 cm. in 1966–67 and 91·63 ± 0·24 cm. in 1967–68) in soils fertilized with 80 Kg. nitrogen per hectare. Under similar conditions, Sonora 64 reaches a height of 80 cm. (mean height 79·20 ± 0·48 cm. in 1966–67 and 80·96 ± 0·26 cm. in 1967–68). Analysis of the F_2 and F_3 progenies of crosses between these two varieties and the tall varieties Chinese Spring, Agra Local, Pissi Local and C 591 showed that dwarfing in Sonora 64 is principally controlled by two independently inherited recessive factor pairs, while in Lerma Rojo a single pair of recessive factors is involved. In order to identify the chromosomes carrying the major