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Connection between climate and tectonics: implication to Kolhan basin

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Abstract: A simple model for the development and evolution of the Kolhan Basin is proposed. The first event consists of a rapid stretching of the continental lithosphere, which produced thinning and passive upwelling of hot asthenosphere. This stage is connected with block faulting and subsidence. This is synchronous to the existence of the Columbia supercontinent. There was no glaciation during the existence of Columbia. This indicates moderate weathering rate during which the Kolhan Basin formed. This simplistic logical conclusion is supported by the predominance of quartz arenite in the sandstone of the basin. The paucity of feldspars in the thin-sections supports the above findings. The main shallow elongated basin of the Kolhan Formation extends from Chaibasa (85° 48', 22° 33') to Noamundi (85°28', 22° 09') covering about 34 miles in length and maximum 10 miles in width along the western extremity of the Singhbhum Granite. The petrography and geochemistry of the basin concludes an intracratonic rift tectonic setting in Proterozoic time. This indicate a granitoid source with moderate chemical weathering. High Al2O3/SiO2 and K2O/Na2O ratios reflect a derivation of all the sediments from stable cratons during tectonic quiescences. These alumina ratio indicates that the clastics were deposited in a passive margin or cratonic margin. The existence of Columbia supercontinent during the life of Kolhan Basin indicates no glaciation during that time. This scenario is well supported by findings of petrography and geochemistry of the basin.

Keywords: quartz arenite, intracratonic, passive margin, Kolhan.

Introduction

The Kolhan Basin in Singhbhum District is unique in Its narrow strip-like outcrop pattern, controlled by the of the much older Iron-Ore Formation synclinorium abuts against the Singhbhum Granite in the east of a greater portion of its trend. A part of eastern and entire western boundary is in contact (fault contact) with the Iron-Ore Formation rocks. The Kolhan

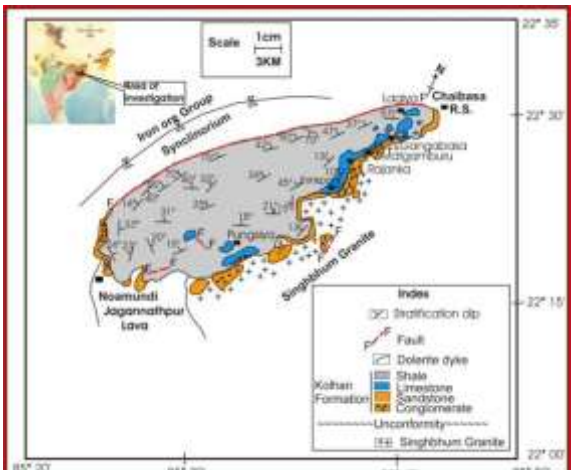

Fig. 1. Geological and structural map of Chaibasa-Noamundi Basin showing the different lithounits (after Chatterjee and Bhattacharya 1969)

Shale Formation is definitely younger than the Iron-Ore Formation as originally suggested by Dunn (1940). The Kolhan Basin is set in a diversified lithological provenance, so that it exhibits the development of a rudaceous, arenaceous, calcareous and an argillaceous facies.

Geology

The main shallow elongated basin of the Kolhan Formation extends from Chaibasa to Noamundi covering about 56km in length and maximum 19 km in width along the western extremity of the Singhbhum Granite (Fig 1). The Kolhan Formation lies over the Iron -Ore Formation and Singhbhum Granite and consists of the basal conglomerate, sandstone, impersistent limestone and with a general westerly. The total thickness of this formation is approximately 100 meters.

Petrography

The Kolhan sandstones are composed mainly of an aggregate of subangular to subrounded quartz embedded in an illitic-clay matrix, with subordinate amounts of feldspar, rock fragments, chert and muscovite, while biotite and chlorite are rare. Table 1 shows the modal analysis of the various constituents in the representative sandstone samples.

Quartz is clearly the dominant detrital mineral constituent with a modal variation from 60.59 % to 82.56 %. Rarely its proportion decreases to 48.77 %. The grains are mostly subangular to subrounded with grain size from 0.06 mm to 1 mm in general. The quartz is dominantly a common unit, slightly vein quartz and strongly undulose quartz are very subordinate in occurrence in the rock. The grains are mostly coated with iron oxide and exhibit authigenic overgrowths which produce euhedral out line in rare cases.

Such overgrowths have replaced the primary hematite coating leaving behind scattered relics of the latter. It is further observed that these overgrowths are rare on that side of the grain which is in contact with the clay.

Recycled quartz grains with abraded outgrowths are occasionally formed. The contacts between the grains are generally plane and rarely sutured and stylolitic. Inclusions of minute apatite, zircon and rutile are rare. They sometimes show gas vacuoles rarely arranged in trails.

The detrital mineral grain next in order of abundance is feldspar which varies in modal proportions from practically nil to about 3%. The grain size variation is from 0.09 to 1 mm and the grains are mostly sub angular and coated with hematite. They are usually altered and show all stages from nearly fresh to almost completely, seriticized in which few fresh relics are present. The feldspar is dominantly detrital

(1) Sample No.	(2) Quartz	(3) Illite-clay matrix.	(4) Silica cement	(5) Hemati-te Cement	(6) Cal-cite Cement	(7) Rock frag-ments	(8) Chert	(9) Felds-pars	(10) Chlorite and Musco-vite	(11) Authi-genic constituents.
1	72.06	13.52	5.84	6.05	-	0.52	1.99	-	-	-
2	67.79	15.37	7.26	7.47	-	0.26	1.42	tr	0.10	0.33
3	69.05	2.84	8.35	15.09	-	1.53	2.37	-	0.76	-
4	70.18	11.89	13.4	1.92	-	-	0.42	2.17	-	-
5	63.16	16.61	7.37	8.44	-	0.66	3.82	-	-	-
6	70.51	13.56	6.12	7.5	-	1.67	0.63	-	-	-
7	70.49	15.04	7.77	5	-	0.49	1.18	-	-	-
8	71.92	8.44	16.43	1.64	-	0.25	1.29	-	-	-
9	60.63	19.86	12.14	5.26	-	-	1	1.10	-	
10	82.31	9.04	5.39	1.61	-	0.05	1.58	-	-	-
11	63.72	19.95	7.91	5.72	-	1.76	0.93	-	-	-
12	71.93	10.53	7.53	5.42	-	1.00	1.61	2.55	-	0.42
13	69.43	1.00	3.98	11.10	12.43	0.56	1.46	-	-	0.04
14	62.03	22.57	5.36	8.19	-	1.84	-	-	-	
15	65.81	0.50	1.25	5.98	23.08	0.02	1.60	1.14	0.27	0.32
16	67.43	5.04	5.16	20.46	-	-	0.39	1.23	tr	0.28
17	65.43	15.73	5.96	10.59	-	0.23	0.26	tr	1.25	0.52
18	69.68	17.37	8.54	2.25	-	0.64	1.17	-	-	0.33
19	63.71	15.28	6.12	11.34	-	0.62	1.39	0.52	0.60	0.40
20	70.90	tr	6.00	17.36	-	3.48	1.76	-	-	0.50
21	68.37	tr	3.5	24.84	-	2.00	1.28	-	-	
22	72.59	6.86	19.5	tr	-	1.00	0.04	-	-	
23	72.33	8.97	11.91	1.62	-	3.50	0.18	1.00	tr	-
24	61.14	19.62	5.72	10.73	-	1.9	0.58	0.25	-	0.2
25	67.44	15.00	7.42	5.47	-	3.32	1.34	-	-	-
26	78.05	tr	7.50	14.45	-	0.63	0.36	-	-	-
27	81.30	2.63	7.01	2.53	-	0.64	4.57	0.40	0.45	0.44
28	52.31	46.85	-	-	-	tr	0.83	-	-	-
29	48.77	40.04	tr	9.00	-	2.19	-	tr	-	-
30	79.11	3.53	7.65	1.08	-	6.52	2.08	-	-	-
31	82.56	12.50	3.98	0.37	-	0.57	-	-	-	-
32	68.24	2.82	7.61	18.84	-	0.65	0.8	0.44	0.27	0.3
33	79.87	0.76	6.79	10.41	-	0.49	1.67	-	-	-
34	70.19	18.39	9.0	1.0	-	-	1.41	-	-	-
35	67.46	1.5	7.5	18.11	-	3.0	2.46	-	-	-
36	67.11	17.37	12.5	-	-	1.01	2.0	-	-	-
37	71.93	tr	15.5	10.45	-	1.9	0.21	-	-	
38	50.94	46.67	-	0.38	-	0.25	0.75	-	1.0	-
39	70.43	23.73	5.5	-	-	-	0.33	-	-	
40	72.94	10.99	11.55	tr	-	2.51	2.00	-	-	
41	63.56	1.0	10.5	19.04	-	2.4	3.48	-	-	
42	63.65	tr	4.0	30.75	-	1.43	0.17	-	-	-
43	79.64	4.94	15.0	tr	-	-	0.42	-	-	
44	68.64	24.56	4.5	tr	-	0.44	1.85	-	-	-
45	73.9	16.91	2.5	2.0	-	1.65	3.0	-	-	-
46	78.31	1.0	10.5	7.73	-	0.9	1.0	-	-	
47	72.94	4.13	9.5	10.0	-	1.41	1.82	-	-	-
48	79.48	1.0	14.5	1.37	-	2.5	1.10	-	-	-
49	60.59	-	tr	35.68	-	2.38	1.12	0.22	-	
50	73.94	2.74	14.5	2.16	-	3.21	2.25	1.19	-	-
51	70.45	3.23	14.65	4.0	-	3.23	2.92	1.52	-	-

52	71.11	3.03	23.5	-	-	1.0	1.35	-	-	tr
53	71.31	1.0	5.65	16.75	-	3.0	1.81	-	-	tr
54	77.28	1.78	18.5	-	-	1.0	1.43	-	-	tr

Table 1. Modal analysis of the Kolhan Sandstones

and includes sodic plagioclase, perthite, microcline and untwinned varieties. Patchy zoning is rare. Microfaulting and bending of the twin lamellae are other features rarely observed in thin sections. Such detrital feldspars show evidence of having been replaced by the slightly recrystallized illite-clay matrix in the rock. In other cases all stages of replacement by muscovite along cleavages are also observed. Authigenic overgrowths on detrital plagioclase are extremely rare.

Sample Nos	Sand size fraction		Silt Clay Fraction		Total Bulk Sample	
	SiO_2%	Al_2O_3%	SiO_2%	Al_2O_3%	SiO_2%	Al_2O_3%
10	63.80	13.80	69.20	9.20	68.52	9.64
11	66.50	13.80	69.20	13.20	68.70	12.96
12	63.39	15.15	78.40	10.20	73.52	11.31
13	55.60	14.20	42.39	13.22	43.33	13.25
16	66.50	12.20	67.40	15.10	66.92	16.09
19	72.28	10.96	67.20	12.64	43.35	
20	66.50	10.50	60.22	27.02	68.71	

Table 2: Partial chemical analysis of the Kolhan Shale

Turbidity in some detrital feldspar grains appears to be due to a swarm of minute vacuoles. Authigenic feldspars are usually angular, small in size, absolutely fresh and show perfect twin lamellae.

Rock fragments – The clastic constituents which form the rock fragments vary in modal analysis from trace amount to 3.5 % and exhibit a size variation of 0.18 mm to 2 mm. They are mostly sub-angular and include in order of abundance the following: micro-granite, meta-quartzite, shale and phyllite, jasper and banded hematite jasper, quartz schist and angular sandstone.

Geochemistry

The results of a of seven specimens of represented in Table 2 which also contains the partial analyses of sand size as well as silt clay size particles separated from the same samples. The SiO_2 content in the five samples of the shale analyzed varies from 43.33% to 73.52%. Silicification is indicated by the high percentage of silica. The Al_2O_3 content varies between 9.64 to 16.09%. The colour of the wet sediment signifies presence of iron rich mineralsX-ray diffraction studies result shows as follows. The preliminary X-ray investigation of the (<2 microns) of a revealed the presence of and certain mixed

layer clay minerals while that of quartz (clay-size). The high alumina content of the silt clay fraction is in agreement with the results of X-ray analysis.

Conclusion

Sediment eroded from these sources typically consist of the sand, feldspar with high ratios of potash feldspar to plagioclase feldspar, metamorphic and sedimentary rock fragments. Sediment eroded from continental sources may be transported off the continent into adjacent marginal ocean basins, or it may be deposited in local basins within the continent. The main shallow elongated basin of the Kolhan Formation extends from Chaibasa (85° 48', 22° 33') to Noamundi (85°28', 22° 09') covering about in width along the western extremity of the Singhbhum Granite. The occurrence of detached outliers of the Kolhan rocks east of the unconformity on Singhbhum Granite and north of Chiabasa suggests the wide extent of the Kolhan basin in the past. High Al_2O_3/SiO_2 and K_2O/Na_2O ratios reflect a derivation of all the sediments from stable cratons during tectonic quiescences. These alumina ratio indicates that the clastics were deposited in a passive margin or cratonic margin. There was no glaciation during the existence of the Kolhan Basin.

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