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COMPARATIVE EVALUATION OF LATERITE DEPOSITS OF PAKISTAN

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Studies on various samples of laterites from Cherat, Attock, Abbotabad, Sargodha and Ziarat areas of Pakistan were carried out by chemical, x-ray powder diffraction and thermal analysis for comparative evaluation. The minerals identified in these laterites are vermiculite, goethite, calcite, limonite, hematite, quartz, kaolinite, diaspore, boehmite and illite.

Key words: Comparison, Laterites, Pakistan.

Introduction

Laterite deposits have been reported in (Cherat) Peshawar, (Abbotabad) Hazara, (Attock) Rawalpindi, (Chapper Salt Range) Sargodha and (Ziarat) Quetta Divisions of Pakistan [1]. These deposits are of variable composition with high silica content (12.21 to 46.90%).

Cherat laterite is exposed at the disconformable contact between Lochart limestone of lower Paleocene age and Patala Formation of upper Paleocene to lower Eocene age [2].

The Attock and Sargodha laterites form lenses at the base of Eocene limestone; whereas the Ziarat laterite is found near the base of Paleocene limestone. The composition of this deposit changes abruptly both laterally and vertically [3].

The Abbottabad laterite deposits are sedimentry layers of hematite claystone with a high content of alumina [1]. The present paper reports comparative chemistry and mineralogy of the laterite deposits of Pakistan.

Experimental

Chemical composition. The laterite samples were analysed chemically by conventional as well as by instrumental methods. SiO_2, Fe_2O_3, Al_2O_3, TiO_2, CaO, MgO, Na_2O, K_2O and L.O.I were determined. The results of the analyses of samples from various areas are given in Table 1.

Thermal analysis. MOM derivatograph (Paulik-Paulik-Erdey [4], Hungary) was used for simultaneous differential thermal analysis (DTA), thermogravimetry (TG) and derivative thermogravimetry (DTG) for all the samples. The experiments were carried out using platinum crucibles and static air atmosphere over a temperature range 20 - 1000°. Heating rate was 10° /min. Alumina (Al_2O_3) heated previously at 1000° was used as reference material. The derivatogram (DTA, TG and DTG curves) was recorded on a photographic chart. Derivatograms of the samples are shown in Fig. 1. The results from DTA, TG and DTG are shown in Table 2.

X-ray diffraction (XRD) analysis. A Seifert X-ray unit with Debye-Scherrer camera (dia=11.4 cm) was used. A

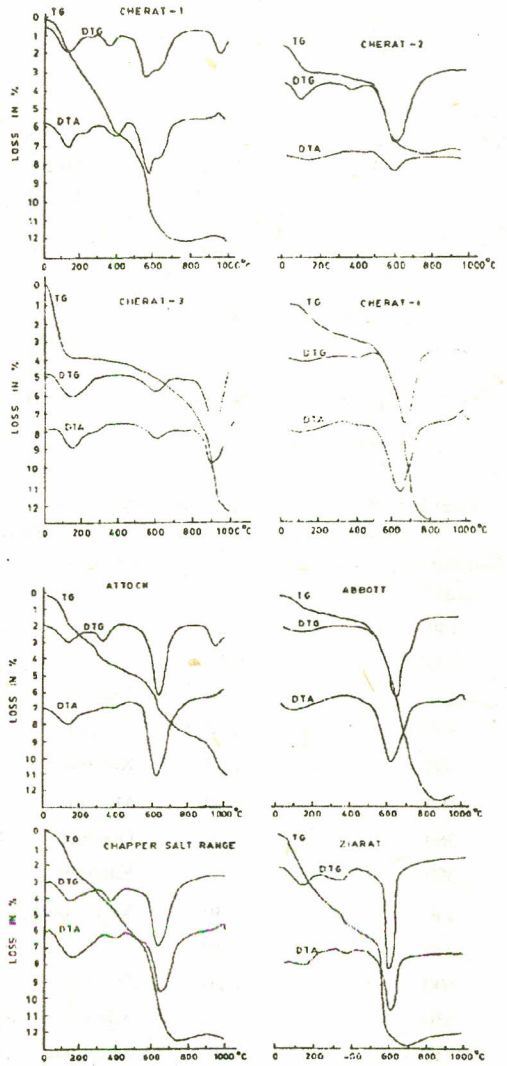

Fig. 1.

paste of the sample was made with a drop of collodion and molded to a cylinder 0.5 mm in diameter and 10 mm in length. The samples were irradiated by Ni-filter Cu K_a radiation for 6 hr at 35 kV and 20 mA. XRD diffractograms of eight samples of laterites from different localities are presented in Fig. 2 and the summary of minerals identified in each sample is given in Table 3.

TABLE 1. CHEMICAL COMPOSITION OF LATERITES.

Composition	Cherat				Attock	Abbottabad	Chapper salt range	Ziarat
	1	2	3	4				
SiO_2	30.10	37.36	48.98	36.10	30.25	12.21	24.21	16.31
Fe_2O_3	24.21	50.10	09.89	13.93	29.87	22.10	21.40	26.35
Al_2O_3	30.13	08.78	16.78	30.41	23.99	50.98	35.12	45.15
TiO_2	1.57	00.69	00.38	00.14	01.18	02.61	01.48	01.68
CaO	0.34	00.31	07.20	05.73	02.98	00.31	01.21	00.10
MgO	0.13	00.12	01.15	00.61	00.21	00.11	01.50	Nil
Na_2O	1.01	00.53	00.71	00.63	00.65	01.03	00.13	00.53
K_2O	1.21	00.64	00.24	00.27	00.29	00.81	00.21	00.21
L.O.I.	11.86	02.99	14.78	13.14	10.98	11.12	18.17	10.20
Total	100.56	101.52	100.11	100.96	100.40	101.28	103.43	100.53
Mineral composition								
Vermiculite	25.30	-	25.60	-	18.00	-	-	2.16
Kaolinite	09.20	12.60	06.60	70.90	49.20	05.20	40.20	5.21
Diaspore	28.50	-	12.60	-	-	56.20	-	-
Boehmite	-	-	-	-	-	-	16.20	44.25
Goethite	18.90	01.70	-	02.00	-	-	20.00	20.10
Limonite	-	-	-	-	08.60	02.30	-	-
Hematite	06.00	48.90	-	14.73	22.11	20.70	01.10	09.50
Calcite	-	-	12.20	-	-	-	-	-
Magnesite	-	-	02.50	-	-	-	-	-
Quartz	12.30	32.50	40.30	09.20	-	12.98	23.16	18.31
Total	100.20	95.70	99.80	96.83	97.91	97.38	100.66	99.53

TABLE 2. RESULTS OF THERMAL ANALYSIS.

Laterites samples	DTA Endothermic peak°C	DTA Exothermic peak°C	TGA % loss	Minerals identified	Percentage
Cherat-1	140		3.20	Vermiculite	26.0
	230		0.53		
	370		1.80	Goethite	18.0
	560		4.50	Diaspor	30.0
	600	940	1.37	Kaolinite	09.5
Cherat-2	100		0.60	Moisture	00.6
	360		0.16	Goethite	02.0
	390	1000	1.80	Kaolinite	13.0
Cherat-3	140		3.30	Vermiculite	26.0
	220		0.40		
	600		2.20	Diaspore	15.0
	630		1.00	Kaolinite	07.0
	750		1.30	Magnesite	02.5
	900	970	4.80	Calcite	11.0
Cherat-4	120		1.00	Moisture	01.0
	370		0.27	Goethite	02.6
	620	980	10.00	Kaolinite	72.0
Attock	140		2.00	Vermiculite	18.5
	230		0.67		
	340		1.30	Limonite	09.0

Table 2 cont. on 2nd colm.

Table 2 continued

	620	990	6.70	Kaolinite	48.0
Abbotabad	120		0.80	Moisture	00.8
	330		0.40	Limonite	02.8
	560		8.67	Diaspore	57.0
	600	990	0.60	Kaolinite	05.0
Chapper	120		3.20	Moisture	22.7
salt range	370		2.00	Goethite	20.0
	480		1.30	Boehmite	09.0
	620	1000	5.70	Kaolinite	41.0
Ziarat	120		2.70	Moisture	02.7
	360		2.10	Goethite	21.0
	590		7.60	Boehmite	50.0

Results and Discussion

The chemical analyses of Cherat laterites indicate abrupt changes in the chemical constituents. SiO_2 varies from 30.10 to 48.98 %, Fe_2O_3 from 9.89 to 50.10 %, Al_2O_3 from 8.78 to 30.41 % and CaO from 0.31 to 7.2 %.

Attock and Chapper salt range laterites are ferruginous whereas Abbottabad and Ziarat laterites are aluminous. Abbottabad laterite contain 50.98 % of Al_2O_3 whereas Ziarat laterite contains 45.15 % of Al_2O_3.

X-ray powder diffraction and thermal studies reveal the presence of some minerals in the laterites of various

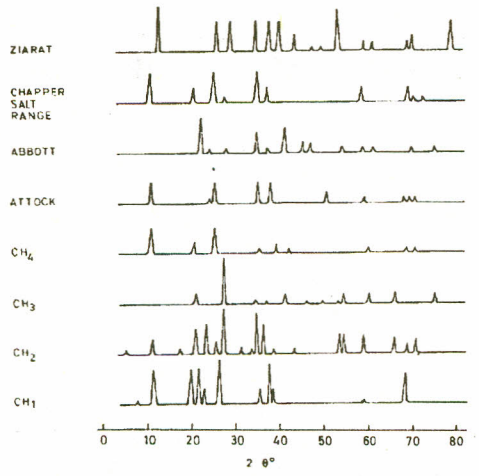

Fig. 2. XRD diffractograms of 8 samples of laterite.

TABLE 3. X-RAY POWER DIFFRACTION RESULTS.

	Whole rock mineralogy						Clay mineralogy			
Sample	Vermiculite	Goethite	Hematite	Calcite	Limonite	Quartz	Illite	Diaspore	Kaolinite	Boehmite
Cherat 1	++	+	+	-	-	+	+	+	++	-
Cherat 2	-	+	+	-	-	++	+	-	++	-
Cherat 3	++	+	-	+	-	++	-	+	+	-
Cherat 4	-	+	-	-	-	-	-	-	++	-
Attock	+	-	+	-	+	-	-	-	++	-
Abbotabad	-	-	+	-	+	-	-	++	+	-
Chapper salt range	++	++	-	-	-	+	-	-	++	-
Ziarat	-	++	-	-	-	-	-	-	-	++

(++) indicates the presence of the mineral in major quantity; (+) Indicates the presence of the mineral in minor quantity.; (-) Indicates the absence of the mineral.

localities e.g. vermiculite, kaolinite, diaspore, boehmite, goethite and quartz in major quantity while limonite, illite and hematite in minor quantity. Limonite ($2Fe_2O_3.3H_2O$) is a hydrated oxide of iron with poorly developed crystalline character and broadened x-ray reflections were observed. Goethite (a $Fe_2O_3.H_2O$) and hematite (a Fe_2O_3) are important constituents of limonite. The mineral constituents calculated by TG and DTG are in good agreement with those calculated by chemical composition (Table 1). The result of the mineral contents in all the specimen by TG and DTG are shown in Table 2. For interpretation of XRD the served data of the samples were compared with that of Brown [5] and ASTM powder diffraction file [6]. The minerals identificed were vermiculite (14, 3.45, 1.53 Å), kaolinite (7.17, 1.49, 3.55 Å), diaspore (3.99, 2.32, 2.13 Å), boehmite (6.11, 3.16, 2.35 Å), goethite (4.21, 2.69, 2.40 Å), limonite (10.10, 2.59, 4.53 Å), hematite (2.69, 1.69, 2.51 Å), calcite (3.03, 2.09, 2.28 Å), quartz (3.34, 4.26, 1.81 Å), and illite (4.46, 3.36, 2.57 Å).

Hematite varies from nil to 48.90 %, goethite from nil to 18.90%, limonite nil to 8.6 %, kaolinite from 6.60 to 49.20%, quartz from 9.20 to 40.30 % and vermiculite from nil to 25.6 % in Cherat laterite. Ziarat laterite contains 9.50 % hematite, 20.10 % goethite, 50.90% boehmite and 18.31% quartz.

The analytical data of Cherat laterite shows that this deposit is of variable composition. The alumina and iron contents of the Cherat deposit are 8.78 to 30.41 % and 9.89 to 50.10% respectively. Location of sample no. 2 with 50.10 % Fe_2O_3 content may be used as a source of iron.

The Attock and Sargodha laterites are poor sources of iron and alumina. Due to high silica (30.25%) content and low iron and alumina contents, these may not be suitable for steel and alumina industries.

The iron content (Fe_2O_3) of Abbotabad and Ziarat deposits is low, 22.10% and 26.35% respectively, whereas the alumina content of Abbotabad and Ziarat deposits is high (50.98 % and 45.15 % respectively). However, detailed studies of these deposits should be carried out before its commercially exploitation for the aluminum and aluminum chemical industries.

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