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SEDIMENT CHEMISTRY OF RIVER JHELUM IN KASHMIR VALLEY (INDIA): AN INDICATIVE OF WEATHERING

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ABSTRACT

Eleven sediment samples have been analyzed to monitor the sediment chemistry of River Jhelum, Kashmir valley, India. The parameters of river Jhelum showed remarkably wide ranges: SiO_2 concentration ranged from (52.3%-78.7%), Al_2O_3 concentration ranged from (9.2%-14.45%), CaO concentration ranged from (1.68%-23.37%), Fe_2O_3 concentration ranged from (3.6%-8.46%), MgO concentration ranged from (0.6%-3.43%), Na_2O concentration ranged from (0.7%-1.5%), K_2O concentration ranged from (0.6%-1%), MnO concentration ranged from (0.3%-0.6%), TiO_2 concentration ranged from (0.7%-1.7%), P_2O_5 concentration ranged from (0.36%-0.6%). River Jhelum is characterized by moderate chemical index of alteration (44-79), reflecting moderate weathering in the source area/catchment of the river. The $K_2OFe_2O_3Al_2O_3$ triangular plot of the samples demonstrate residual clay formation and $Al_2O_3(CaO+Na_2O)K_2O$ triangular plot demonstrate trend of plots towards the Al_2O_3 apex and are away from PAAS, thus booth triangular plots indicate moderate weathering at the source. Comparing River Jhelum sediment data to the post-Archean shale (P.A.S), upper continental crust (U.C.C) and (NASC) the sediments have higher SIO_2 , CaO and TIO_2 content indicating moderate weathering at the source and predominance of carbonate lithology and lower Al_2O_3 and Fe_2O_3, MgO, Na_2O, K_2O, MnO and P_2O_5 content, which could be ascribed to the dilution effect of $CaCO_3$.

Key Words: Jhelum, chemical index of alteration, weathering, post-Archean shale, Upper continental crust, carbonate lithology

INTRODUCTION

Sediments result from weathering of rocks in the catchments. During weathering elements may become separated from the rocks as dissolved species or colloids or they may remain as primary resistate minerals in the catchment area (Chakrapani, 2002). The sediment particles absorb many contaminants, such as pesticides, radionuclides and toxic metals that are transported, deposited and stored as part of the sedimentary component of the river system (Milliman *et al.*, 1984). sediment quality is an important environmental concern because sediments may act as both a sink and source of water quality constituents to the overlying water (Baudo *et al.*, 1990). Metals are an important determination of sediment quality because of their potential toxicity (Forstner and Wittmann, 1981). These metals often are redistributed by irrigated agriculture (Sharma and Singh, 1983). An analysis of river sediments can provide historical information on sediment deposition as well as, magnitude and trends of metal concentration. A number of studies

pertaining to sediment chemistry of rivers have been carried out by various workers (Das, 2003; Chakrapani, 2002; Ahmad, 1998; Chakrapani and Subramanian, 1989; Christensen and Juracek, 2000).

Keeping in view the versatile role of sediments in river systems present study has been carried out.

MATERIALS AND METHODS

Study Area

After its origin from Pir Panjal range of mountains the Jhelum flows through the Kashmir valley in north westerly direction till it falls into the Wular lake in Baramulla District. After its re-emergence from the Wular Lake in Sopore (Fig. 1), it takes a southwesterly direction and continues its journey through Uri before entering the Pakistan occupied Kashmir.

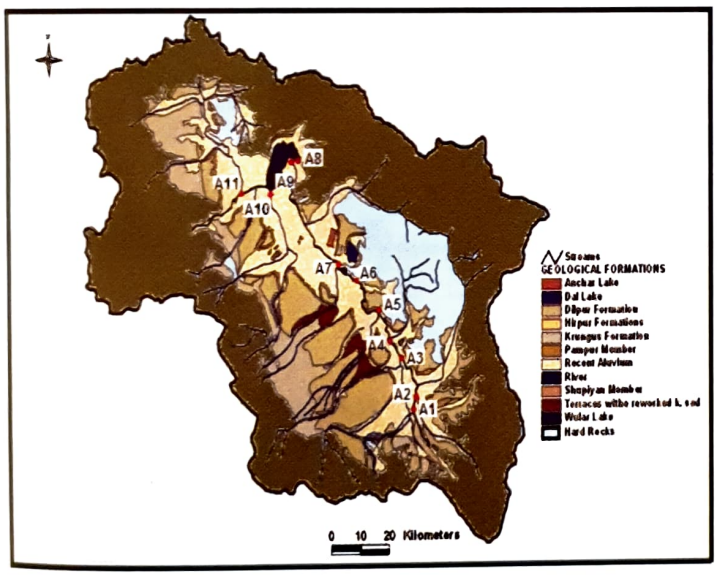

Fig.1. Map of River Jhelum and sampling locations

Sampling and Analysis

Freshly deposited bed sediments samples (n= 11) were collected from River Jhelum, with the help of scoop. Samples were packed in polythene bags prior to analysis; dried and properly mixed and an aliquot of each sample was powdered in a tima mill to approximately 200 mesh. Geochemical analysis of the sediments was carried out by decomposition of each sample with HNO_3, HCl, H_2SO_4 and HF mixture (Shapiro and Brannock, 1962). Atomic absorption spectrophotometer was used for the determination of Si, Al, Ca, Mg, Fe, P, Ti, Mn. Na and K were analyzed by flame emission photometer.

RESULTS AND DISCUSSION

Summary of river Jhelum sediments reveals little spatial variability (Table 1). SiO_2 concentration ranged from 52.3%-78.7%, Al_2O_3 concentration ranged from 9.2%-14.45%, CaO concentration ranged from 1.68%-23.37%, Fe_2O_3 concentration ranged from 3.6%-8.46%, MgO concentration ranged from 0.6%-3.43%, Na_2O concentration ranged from 0.7%-1.5%, K_2O concentration ranged from 0.6%-1%, MnO concentration ranged from 0.3%-0.6%, TiO_2 concentration ranged from 0.7%-1.7%, P_2O_5 concentration ranged from 0.36%-0.6%.

The data reveals that SiO_2 and Al_2O_3 were the most dominant elements which together constitute >80% of the total elemental composition and the order of elemental composition was $SiO_2 > Al_2O_3 >$ CaO> Fe_2O_3> MgO > **Na_2O%** >K_2O > **MnO%** >TiO2 >P_2O_5.

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Table. 1. Average chemical composition of River Jhelum bed sediments (major Oxides in wt%)

Location	Site ID	SiO_2%	Al_2O_3%	CaO%	Fe_2O_3%	MgO%	Na_2O%	K_2O%	MnO%	TiO2%	P_2O_5%
(Kursherpur)											
Khanabal (Gur)	A1	63.8	13.2	7.5	7.4	2.82	0.8	1	0.3	0.9	0.3
Khanabal	A2	58.3	12.1	13.6	8.4	0.8	0.9	0.8	0.4	1.5	0.4
Sangam	A3	70.5	12.1	6.1	4.1	1.61	1.5	0.9	0.5	0.9	0.4
Kakapora	A4	62.5	11.3	6.1	6.3	1.8	1.2	0.8	0.3	1.3	0.4
Awantipora	A5	78.7	9.2	1.6	4.3	0.6	1.2	0.9	0.6	0.9	0.3
Srinagar (Amirakadil)	A6	65.1	14.4	11.2	6.9	2.42	0.9	0.8	0.3	1.2	0.6
Shadipora	A7	63.3	13.6	7.5	6.1	3.43	0.7	0.9	0.4	1.2	0.4
Bunyar	A8	72.3	12.6	5.1	3.6	0.6	1.5	0.8	0.4	0.7	0.3
Gulamyar	A9	71	11.8	4.2	5.8	0.6	0.7	0.9	0.6	0.8	0.6
Sopore (D)	A10	69.6	16.6	2.5	4.3	1.2	1.4	0.6	0.4	0.9	0.7
Sopore (N)	A11	73.7	12	1.9	4.4	1.01	1.4	0.8	0.4	0.8	0.3

SiO_2, a dominant oxide in the earth's crust varied rapidly don the river however Al_2O_3 concentration showed little spatial variation down the river (Fig. 2a). CaO, Fe_2O_3 and MgO showed little spatial variation down the river however at location Srinagar the concentration increase, which might be due to presence of carbonate lithology. Na_2O also showed little spatial variation (Fig. 2b).

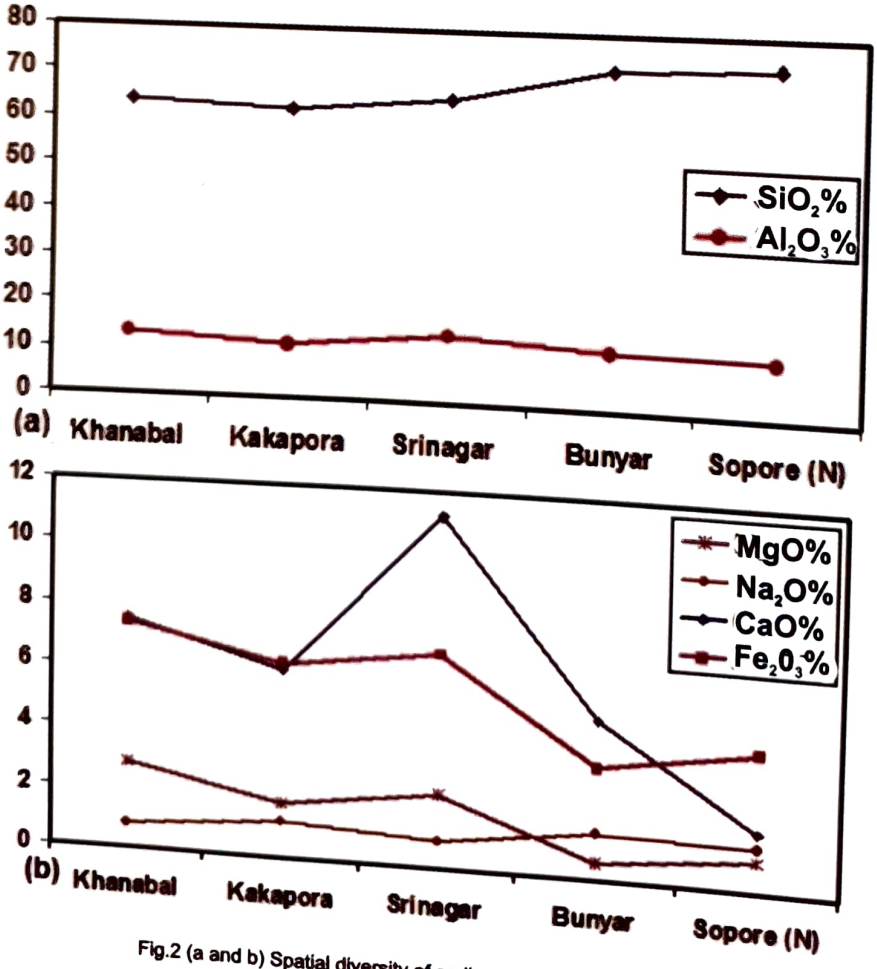

Fig.2 (a and b) Spatial diversity of sediment samples from river Jhelum

Nesbitt and Young (1982) defined a chemical index of alteration (CIA) to quantify the degree of weathering (in molecular proportions), where CaO represents Ca in the silicate fraction only. CIA= $\{Al_2O_3 / Al_2O_3 + CaO + Na_2O + K_2O\}100$

A CIA value for average shales ranges from 70 to 75, which reflects the composition of muscovites, illites and smectite. Intensely weathered rock yields mineral compositions trending towards kaolinite or gibbsite and a corresponding CIA that approaches 100.

CIA value of 45-55 indicates no weathering, where as CIA of 100 indicates extreme weathering (Chakrapani, 2002). In river Jhelum bed sediments CIA values ranged from (44-79) which is moderately higher than the average shale values thus indicating moderate weathering in the source area/catchment of the river.

The weathering trend as depicted on $Al_2O_3(CaO^*+Na_2O)K_2O$ (Fig. 3a) molecular proportion plot (Nesbit and Young,1982) , indicating trend of plots towards the Al_2O_3 apex, attesting to fair weathering conditions. Similarly, in $K_2OFe_2O_3Al_2O_3$ molecular proportion plot (Fig. 3b) the River sediment lie in the field of shales eventually at the junction of overlapping residual clays which may be forming due to leaching of illite; thus again indicating fair weathering in the source area (Wronkiewiez and Condie,1987); supporting $Al_2O_3(CaO^*+Na_2O)K_2O$ plot.

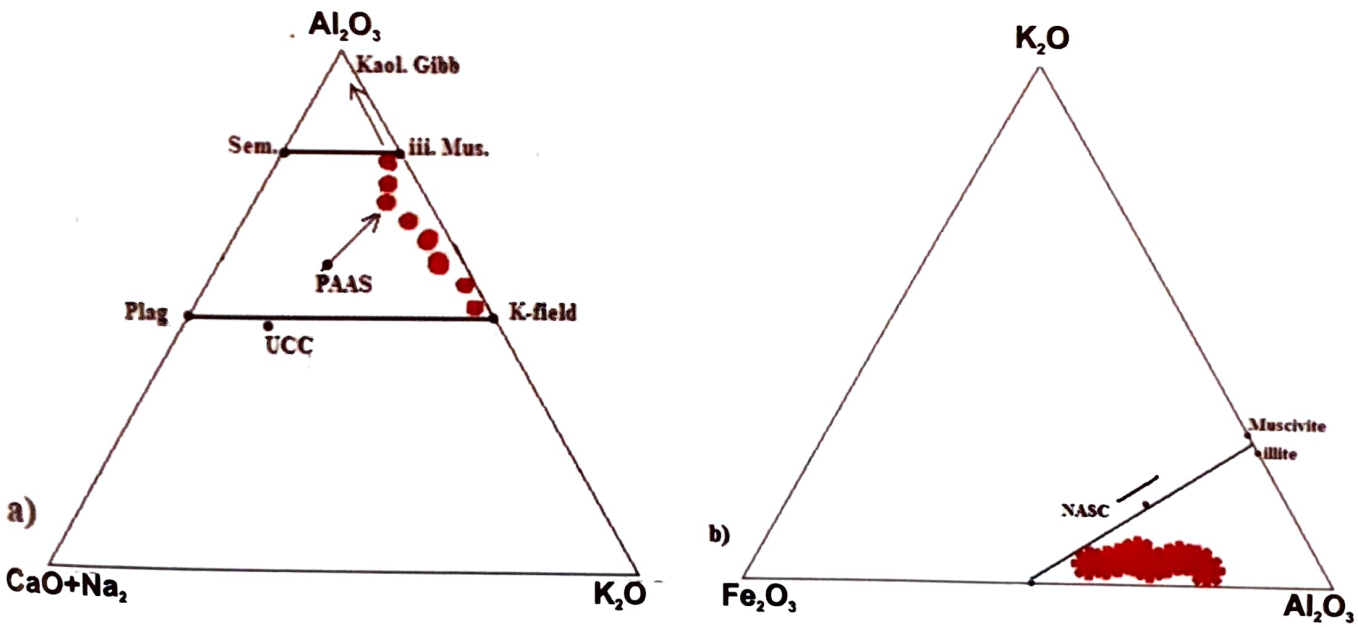

Fig. 3. (a) $Al_2O_3(CaO^*+Na_2O)K_2O$ (b) $K_2OFe_2O_3Al_2O_3$ molecular proportion plots, showing weathering trend at the source

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Element	Average River Jhelum	PAAS	UCC	NASC
SiO_2%	67.92	62.8	66.0	64.8
Al_2O_3%	12.26	18.9	15.2	16.90
CaO%	6.52	1.30	4.2	3.56
Fe_2O_3%	5.78	7.23	5.0	6.33
MgO%	1.57	2.20	2.2	2.85
Na_2O%	1.08	1.20	3.9	1.15
K_2O%	0.86	3.70	3.4	3.99
MnO%	0.42	0.11	0.08	0.06
TiO_2%	1.02	1.0	0.5	0.78
P_2O_5%	0.43	0.16	-	0.11

To critically evaluate the source and extent of weathering in the provenance, data of river Jhelum bed sediments have been compared with average UCC, PAS and NASC (Table.2) which indicates that SIO_2 , CaO and TIO_2 were enriched, indicating moderate weathering at the source and predominance of carbonate lithology (Bhatia,1983 and Das and Dhiman, 2003). Elements like Al_2O_3 and Fe_2O_3, MgO, Na_2O, K_2O, MnO, P_2O_5 plunge under the desired limits prescribed by (P.A.S), (U.C.C) and (N.A.S.C) which could be ascribed to the dilution effect of $CaCO_3$.

CONCLUSIONS

From the forth going discussion following conclusions were drawn :

1. SiO_2 and Al_2O_3 were the most dominant elements present in river Jhelum bed sediments.
2. CIA values of river Jhelum bed sediments ranged from (44-79) which is higher than the average shale values; thus indicating moderate weathering in the source area/ catchment of the river.
3. Molecular Proportion plots of $Al_2O_3(CaO^*+Na_2O)K_2O$ and $K_2OFe_2O_3Al_2O_3$ again indicate fair weathering in the source area.
4. By comparing the data of river jhelum bed sediments with average UCC, PAS and NASC; indicates that SIO_2, CaO and TIO_2 were enriched, which is indicative of moderate weathering at the source and predominance of carbonate lithology.

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