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Texture and major element geochemistry of channel sediments in the Orsang and Hiren River Basins, Gujarat, India: Implications for provenance and weathering

Keshwala Nikunj[1], Maurya Shivam[1], Gurav Chandrakant[2] A. and More Laxman[1,3,*]
[1]Parul Institute of Applied Sciences, Parul University, Vadodara - 391760, Gujrat, India
[2]School of Earth Sciences, Punyashlok Ahilyadevi Holkar Solapur University, Solapur - 413255, Maharashtra, India
[3]Yashwantrao Chavan College of Science, Karad - 415124, Maharashtra, India
[*]Email Address: morelaxman70@gmail.com

ABSTRACT

Size, shape, degree of sorting, and composition of sediments in the river channels are controlled by climate, lithology, weathering, sorting, and medium of transportation. The present investigation is focused on the grain-size and geochemical analysis of the channel sediments of the Orsang and Hiren river basins. Major outcrops in the study area are Archaean granites, granitic gneisses, Upper Cretaceous to lower Eocene Deccan Volcanic Basalts (DVB), Quaternary sediments and minor proportion of Proterozoic low grade metamorphic rocks. The sediments are poorly to moderately sorted, very finely skewed, suggesting its derivation from heterogenous sources, while the kurtosis value indicates a high-energy depositional environment. The sediments are with gravelly sand texture and the mean grain size is varying from 581.9µm to 1284.2µm. The DVB provenance of the Hiren river basin and granitic provenance of the Orsang river basin is clearly reflected in the texture and geochemical composition of sediments. The TiO_2 and Fe_2O_3 contents of sediments from the Hiren river basin are distinctly higher and are comparable to the basalts of the Saurashtra region of the Deccan Province. Sediments collected after Orsang and Hiren rivers confluence and from Narmada river show higher concentration of felsic sources, indicating that Orsang river's sediment supply significantly outweighs Hiren rivers. The arkosic-litharenite nature points towards less transportation and moderate chemical weathering for the Orsang river sediments. The low Chemical Index of Alteration (CIA) values (Avg. 48.45 and 56.99 for Orsang and Hiren rivers, respectively) and A-CN-K plot also suggest the supply of sediments from minimally weathered detritus under a semi-arid condition.

Keywords: Sediments, Grain Size, Orsang River, Provenance, Transportation, Weathering

INTRODUCTION

River sediments are unconsolidated fragments of pre-existing rocks that have undergone both mechanical and chemical weathering. Both weathering and erosion contribute to the degradation of the rocks, but this degradation has different impact on different types of rocks (Joshua and Oyebanjo, 2010). The size and shape of sand grains in the river provide ideal information about transportation media (Bui et al., 1989); they also provide clues on sediment discharge rates and the environment during deposition of sediments (Gray and Simões, 2008; Williams, 2012). The distribution of sand grains is largely influenced by three key processes: sediment movement, sediment aggregation, and depositional mechanism (Wai et al., 2004). Sediment textures and geochemistry have been extensively used to extract information on provenance, weathering conditions, tectonics, fluvial processes, and paleoclimate conditions (Nesbitt and Young, 1982; Bhatia, 1983; McLennan et al., 1983; Taylor and McLennan, 1985; Wronkiewicz and Condie, 1987; Cullers et al., 1988; Fedo et al., 1995; Sharma et al., 2013). In this context, grain-size data provide clues to sediment provenance, transport history, depositional conditions, and classifying sedimentary facies and environments, which are largely controlled by the nature of the source rock and the transport agent (e.g., Folk and Ward, 1957; Friedman, 1979; Singh and Rajamani, 2001; Bernabeu et al., 2002; Guti errez-Mas et al., 2003; Benavente et al., 2005; Garzanti et al., 2011) while geochemical characteristics reveal the provenance, nature and degree of weathering at the source region of sediments, which is controlled by lithology, climate, and tectonics (Taylor and McLennan, 1985; Singh, 2009; Mondal et al., 2012; Hernández-Hinojosa et al., 2018). In addition, reworking also affects the chemical composition of sediments (McLennan, 1982; Cox and Lowe, 1995). Several authors have investigated the fluvial sediments of Indian rivers to understand the source and process controls on the geochemistry of sediments (Jain and Tandon, 2003; Juyal et al., 2006; Sanyal and Sinha, 2010; Garçon and Chauvel, 2014; Maharana et al., 2018). However, textural and geochemical studies on the fluvial sediments from Orsang and Hiren river basins, which are part of west-flowing river system, are yet to be studied. Additionally, distinctly different spatio-temporal geologic domains are traversed by Orsang and Hiren rivers, making them strongly suitable for understanding provenance control. The data generated in the present study will