Geochemical variations in heavy minerals as provenance indications: application to the Tigris river sand, northern Iraq

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ABSTRACT - Heavy mineral assemblages of the Holocene sediments from the Tigris River in northern Iraq include opaque minerals such as magnetite, chromite and/or chromian spinels, hematite, ilmenite, goethite and pyrite, and non-opaque minerals including epidotes, pyroxenes, amphiboles, garnet, zircon, tourmaline, rutile, kyanite, staurolite, olivine, sphenke, apatite, white mica, biotite and chlorite. Mineralogical and chemical characteristics of the heavy minerals were determined using standard petrographic and electron microprobe analyses. Opaque minerals and epidotes increase in content downstream, mica decreases, whereas amphiboles, pyroxenes and garnet show irregular distributions. Chemical characteristics of selected heavy minerals suggest their derivation from a complex of metamorphic and igneous source rocks. Based on the mineralogical and geochemical signatures, heavy minerals closely reflect mafic and ultramafic igneous rocks, metamorphites, and the ophiolitic complexes of northeastern Iraq and southern Turkey.

KEY WORDS: provenance; heavy minerals; mineral chemistry; Tigris River; Iraq

INTRODUCTION

Heavy minerals have been widely used to study the weathering processes, provenance and diagenesis of siliciclastic rocks (Mange and Maurer, 1992; Dill, 1998; Morton and Hallsworth, 1999 and Arribas et al., 2000). The study of the chemistry of some heavy minerals is a useful tool for better discrimination of the source rocks. Significant information of provenance and tectonic settings can derive from analyses of heavy mineral suites (Morton, 1985; Basu and Molinaroli, 1989; Arai and Okada, 1991; Cookenboon et al., 1997; von Eynatten and Gaupp, 1999; Hisada et al., 2002). Heavy mineral assemblages in river sediments closely reflect the nature of the source area, although their composition is affected by a number of other processes occurring during the sedimentary cycle, such as weathering in the source area, the effects of the transportation process, the hydraulic selection at the depositional environment and the diagenetic processes (Morton and Johnsson, 1993).

The general pattern of the source rocks of the Tigris and Euphrates rivers sand is well constrained upon study of heavy mineral assemblages (Philip, 1968; Jawad Ali, 1977). Al-Juboury et al. (2001 a, b) studied the texture and mineralogy of the Holocene sediments of the Tigris River and its tributaries in northern and northeastern Iraq and explained the distribution of these heavy minerals as a consequence of different grain size in the Holocene sediments in addition to the source areas. They also found that the sandy sediments of the Tigris River are finer than those of the Greater and Lesser Zab Rivers and other seasonal tributaries. These sediments show different sorting due to the composition of source rocks and different modes of transportation. Mineralogically, they are composed of quartz, feldspars, mica, rock fragments (mainly sedimentary) and heavy minerals.

The chemistry of the heavy minerals is used in order to provide new information on provenance area (Morton, 1991; Acquafredda et al., 1997). Based on mineralogical and geochemical characteristics of the heavy minerals, the present work attempts to investigate provenance and transport mechanism of the Holocene Tigris River sand in the northern sector of Iraq.

GEOLOGY AND GEOMORPHOLOGY

The regional geology of northern Iraq consists of the Zagros Mountain Range with a NW-SE structural trend in the northeastern part, and the E-W trending Taurus Range in the...