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Combining morphometric parameters and remote sensing data for neotectonic analysis in the Mesopotamia Plain of Iraq

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ABSTRACT

The Mesopotamian Plain in Iraq is affected by significant neotectonic activity, which is expressed through distinct geomorphological characteristics. This study objects to assess the morphotectonic activity of Mesopotamian region by analyzing alluvial fans developed along its northeastern and southwestern margins. The tectonic activity can impact landform development, which is critical for mineral exploration and resource assessment. The integration of morphometric parameters with remote sensing data helps in identifying zones of active tectonics that could host economic mineral deposits. Morphometric and relative active tectonics indices, including sinuosity of mountain front (SMF), valley floor width to height ratio (VF), and the indices of relative active tectonics (IRAT), were derived using Digital Elevation Model (DEM) and Geographic Information System (GIS) techniques. Geomorphometric results indicate that the eastern margin of the Mesopotamian Plain, corresponding to the Zagros fold and thrust belt, shows an average IRAT value of approximately 1.93. In contrast, the western margin displays higher and more variable IRAT values, with values of 3.0 in the southwestern sector, 2.75 in the northwestern sector, and 2.5 in the central sector. Overall, the findings suggest that active tectonic processes operate along both the eastern and western margins of the Mesopotamian Plain. The eastern margin, particularly the northern sector associated with the Mandali Fault, exhibits relatively elevated tectonic activity, whereas the western margin shows fluctuating activity. Medium to elevated tectonic motion is inferred for the central western sector, while the southern and northern parts of the western margin record medium to low tectonic activity.

1. Introduction

The Mesopotamia area occupies the southern and middle areas of Iraq and is located between (29° 52 '30 ″- 35° 22′ 30″) N and (43° 00 00 '00 ″- 48° 30′ 00″) E (Fig. 1). It is bounded from the northeast by Makhoul (the first higher and topographic great anticlinal), Ḥimreen, Badra, and Buzurgan which are connected with the fault of Makhul-Ḥemrin (Zagros Front Fault). Additionally, the region's southern border, extending northwest to Al-Ramadi city, intersects with the Abu Jir-Euphrates Faults Zone, afterward swinging stridently in an NS follow to track the Tharthar valley and terminating next to the Makhoul series and from the Arabian Gulf, which borders to the south. The population in the Mesopotamian Plain, specifically in central and southern Iraq, is approximately 20 million people (World Bank, 2021).

Neotectonics is the tectonic movement that ranges from the upper Tertiary (Neogene) to the recent, according to Obruchev (1948). Neotectonics, as defined by many authors recently, is the study of the earth's crust's structures at post-Miocene (Gary et al., 1972; Bates and Jackson, 1980). However, it took it a step further and limited the neotectonics period to the Quaternary.

After reviewing several literary works related to alluvial fan studies, it can be defined as one of the most prominent geological structures that often occurs where a stream channel runs from the surrounding valley to the mountain uplands. Fluvial aggradation and hydrological processes, as well as tectonic activity and climate change, are the causes of these depositional fluvial landforms. According to Blissenbach (1954), Blair and McPherson (1994a, b), Bull (1977), Weissmann et al. (2005), Jones et al. (2014), Ḥarvey (2018) and Raha et al. (2023), the fan form is characterized by a section of a funnel or triangle form.

A relevant method for identifying, characterizing, and assessing landform changes across thousands to millions of years is a review of geomorphologic characteristics (Bull, 2007; Keller and Pinter, 1996). Jaddoa et al. (2025) showed that landscape change as a result of geomorphic processes that are ultimately governed by tectonics,

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