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Petrological and geochemical constraints on provenance, paleoweathering, and tectonic setting of the Cambro-Ordovician Khabour Formation, western and northern Iraq

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Abstract: Petrographic descriptions and point counting data, supported by SEM analysis, are presented for 89 sandstone samples of the Khabour Formation from the Khabour, Ora, Chalki Nasara, and Chia Zinnar outcrop sections in northern Iraq. These are compared with previously published data for subsurface samples from the Akkas-1 and Akkas-3 wells in western Iraq. Petrographic observations revealed that sublitharenites and subarkoses form the main sandstone types and may suggest a granitic source region with minor input from metamorphosed sediments. This is supported by the geochemical analysis gained from 66 sandstone samples. Chemical Index of Alteration (CIA) and Index of Chemical Variability (ICV) values along with A-CN-K trends, and Th/U versus Th relationships suggest moderate weathering and humid climatic conditions in the source area. The paleoclimate geochemical proxies are supported by clay mineral associations revealed by XRD and SEM data. Up-section trends in Rb/Sr values imply that humid and dry conditions prevailed during the deposition of the Khabour succession. The Khabour Formation sandstones were deposited in a passive margin setting; however, their ultimate origin is likely to be recycled orogen and continental block provenances with sTable craton sources and with uplifting in the basement complexes

Key words: Source area, tectonic setting, Khabour Formation, geochemical constraints, paleo-weathering

1. Introduction

The provenance and tectonic setting of siliciclastic rocks are commonly interpreted from the data gained from a combination of petrographic, mineralogic, and geochemical data (Dickinson, 1970; Dickinson and Suczek, 1979; Roser and Korsch, 1986; Pettijohn et al., 1987; Hussain et al., 2004; Zimmermann and Spalletti, 2009; Saydam Eker and Korkmaz, 2011; Al Juboury, 2012; Cao et al., 2012; Armstrong Altrin et al., 2012; Saydam Eker, 2012; Omer and Friis, 2014; Armstrong Altrin et al., 2015; Basu et al., 2016; Dai et al., 2016; Bessa et al., 2020; Cusack et al., 2020; Al Juboury et al., 2021; Jafarzadeh et al., 2022; Ghasemlooytakantapeh et al., 2023). Thus, the chemical and mineralogical chemical composition of siliciclastic sedimentary rocks is decisive in their provenance (Dickinson, 1970; Dickinson and Suczek, 1979; Saydam Eker and Korkmaz, 2011; Saydam Eker, 2012; Basu et al., 2016).

Additionally, the geochemical composition of siliciclastic sediments has been widely used to determine the degree of weathering of the source area (e.g., Nyakairu and Koeberl, 2001; Madhavaraju and Ramasamy, 2002; Al Juboury, 2012; Zhang et al., 2013; Rahman et al., 2014; Akkoca and Karatas, 2019; Omer et al., 2021). However, the components of clastic sedimentary rocks depend on several factors, such as weathering, recycling, transportation, deposition, and diagenesis. Many of these processes may have been repeated several times in the history of sedimentary rock, modifying most of the original features of its parent rock assemblage (McCann, 1991; Cox et al., 1995; Ghosh and Sarkar, 2010; Garzanti et al., 2013; Saydam Eker and Arı, 2020).

The Khabour Formation (Cambro–Ordovician) crops out in extreme northern Iraq and has been recorded from several wells in western Iraq. The thickest section drilled to date is 1913 m from the Akkas-1 well (Al Hadidy, 2007), whereas at its type section in the Khabour Valley, an 800 m thick section is exposed (Van Bellen et al., 1959; Blanc et al., 2012).

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