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Provenance of detrital zircon from siliciclastic rocks of the Sebkha Gezmayet unit of the Adrar Souttouf Massif (Moroccan Sahara) – Palaeogeographic implications

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ABSTRACT

The Oued Togba and Sebkha Gezmayet units of the Adrar Souttouf Massif in the southern Moroccan Sahara are thought to represent tectonic fragments that may have an affinity to the Avalonian and Meguma terranes of eastern North America. Here we study siliciclastic rocks of the Sebkha Gezmayet unit with respect to their detrital zircon spectra. Beside the commonly used U–Th–Pb ages, several aspects of zircon morphology (length, width, roundness, surficial indicators of sedimentary transport, morphotype) are described. The detrital zircon age spectrum of the Sebkha Gezmayet unit resembles that of the already dated underlying igneous rocks. Occurrences of Early Devonian zircon ages are at odds with the magmatic history of the West African Craton but are common in the Avalonian and Meguma terranes, which were affected by the Appalachian orogenies. The scarcity of Mesoproterozoic detrital zircon grains corroborates the previously suggested Meguma terrane affinity of this part of the Adrar Souttouf Massif. Combining zircon morphology and isotopic data, we propose first assumptions on the sedimentary environments of the Sebkha Gezmayet unit during different periods of the Palaeozoic.
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1. Introduction

After a period of geoscientific quiescence in the last third of the 20th century (Villeneuve et al., 2015), the Adrar Souttouf Massif in the southern Moroccan Sahara became again a subject for geological studies. Most of them focussed on geochronology, but were almost exclusively limited to igneous rocks and their metamorphic equivalents (Bea et al., 2016, 2017; Gärtner et al., 2013a, 2016a, 2016b; Montero et al., 2014, 2016; Villeneuve et al., 2006).

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Data obtained from these studies clearly show differences in the magmatic (Bea et al., 2016, 2017; Gärtner et al., 2013a, 2016a; Montero et al., 2014, 2016) and crustal evolution (Gärtner et al., 2016a, 2016b) of the Adrar Souttouf Massif's four main units, as introduced by Villeneuve et al. (2006). Of them, the Oued Togba and Sebkha Gezmayet units form the western parts of the massif. Both of the latter contain some igneous rocks of Early Devonian age (Gärtner et al., 2013a), which partially show signs of almost coeval metamorphic overprint (Bea et al., 2017). Additionally, the igneous and ortho-metamorphic rocks of the Oued Togba unit contain a remarkable inheritance of Mesoproterozoic zircon grains. Neither Devonian nor Mesoproterozoic magmatism is known from the West African Craton (Ennih and Liégeois, 2008; Gärtner et al., 2017; Linnemann et al., 2011). However, the Avalonian and Meguma terranes that were accreted to Laurussia during the Mid-Palaeozoic comprise many Devonian igneous complexes (Pollock et al., 2012; van Staal et al., 2009). Furthermore, most of the Avalonian terranes have a prominent sub-peak of Mesoproterozoic zircon ages. Hence, the westernmost Oued Togba unit was thought to be of Avalonian affinity, while the adjacent Sebkha Gezmayet unit to the east could be somehow linked to the Meguma terrane (Gärtner et al., 2013a, 2016b). Despite the very limited access to the working area and very limited outcrops, this study aims to prove the latter by analysing the detrital zircon record of the sedimentary rocks of the Sebkha Gezmayet unit.

2. Geological setting

The Adrar Souttouf Massif comprises four SSW–NNE-trending tectonic units that form multiple thrust sheets, which were partially thrusted above each other with an eastward vergence during Ediacaran, but finally during Carboniferous contractional deformation events (e.g., Gärtner et al., 2013a, 2016a; Villeneuve et al., 2015; Fig. 1). These tectonic units are termed from west to east (Villeneuve et al., 2006, 2015): Oued Togba, Sebkha Gezmayet, Dayet Lawda, and Sebkha Matallah units (Fig. 1). A thin skin model is assumed for the entire massif (e.g., Michard et al., 2008, 2010; Sougy, 1962; Villeneuve et al., 2006) that is corroborated by geophysical data (Fateh, 2008; Labails et al., 2010), as well as potential basement windows of igneous rocks of the western Reguibat Shield in the Oued Togba and Sebkha Matallah units (Gärtner, 2017; Gärtner et al., 2013a).

The eastern margin of the Adrar Souttouf Massif is thrusted over a thin succession of Latest Ordovician to Devonian siliciclastic rocks and shallow marine limestone, termed the Dhloat Ensour unit (Gärtner et al., 2017; Villeneuve et al., 2006). A diamictite at the base of the succession likely results from the Hirnantian glaciation (Destombes et al., 1969; Lécorché et al., 1991; Michard et al., 2010; Rjimati et al., 2002a; Sougy, 1969), whereas the biocenosis in the uppermost limestones point to a Lochkovian age (Sougy, 1962). This links the thrusting of the Adrar Souttouf Massif over the Dhloat Ensour unit to the Variscan Orogeny (e.g., Bronner et al., 1983; Rjimati et al., 2002a; Sougy, 1962; Sougy and Bronner, 1969).

Recent studies on zircon age populations of igneous and metamorphic rocks revealed an Avalonian affinity of the Oued Togba unit, while the Sebkha Gezmayet unit resembles the known zircon age spectra of Meguma (Gärtner et al., 2013a, 2016b). Both units are mainly made of felsic igneous rocks of almost exclusively Neoproterozoic to Permian age and their metamorphic equivalents (Bea et al., 2017; Gärtner et al., 2013a; Montero et al., 2016, 2017), but also contain siliciclastic (meta-) sedimentary rocks of yet unknown age (see below). The Dayet Lawda unit in the central part of the massif comprises mafic igneous rocks in all stages of metamorphic overprint up to granulite facies (Bea et al., 2017; Gärtner et al., 2016a). In some parts, this unit hosts occurrences of non- to weakly deformed granitoid rocks, diorite and felsic tuff, while any kind of sedimentary rock has not yet been found (Gärtner et al. 2016a; Villeneuve et al., 2015). The Dayet Lawda unit is interpreted as an oceanic island arc that was active at ca. 635 Ma, and which underwent high-grade metamorphic conditions during a collisional event at about 605 Ma (Gärtner et al., 2016a). As a result, parts of this unit were obducted onto the proto-Sebkha Matallah unit to the east that rests unconformably on the West African Cratons' igneous basement.

The Sebkha Matallah unit forms the easternmost part of the Adrar Souttouf Massif and comprises a variety of metamorphic rocks (e.g., amphibolite, migmatite, phyllite) cut by mafic dykes. Felsic igneous rocks occur scattered in this unit (e.g., Bea et al., 2016). The northern and eastern parts of this unit are covered by Neoproterozoic to Earliest Cambrian, weakly deformed siliciclastic rocks (e.g., Rjimati et al., 2002a, 2002b). Zircon data from the Sebkha Matallah unit suggest a strong relation to the adjacent Reguibat Shield (Bea et al., 2013, 2016; Gärtner et al., 2016a, 2017; Montero et al., 2014, 2016). However, most of these data were obtained from magmatic or metamorphic rocks, which allow only limited palaeogeographic reconstructions due to often scarce inheritance of older zircon age groups. As this study is dedicated to the sedimentary rocks of the Adrar Souttouf Massif, the information referring to the igneous and metamorphic rocks can be consulted in other works (e.g., Bea et al., 2016; Gärtner et al., 2013a, 2016a, 2016b; Montero et al., 2014, 2016, 2017; Villeneuve et al., 2006, 2015).

2.1. The sedimentary rocks of the Adrar Souttouf Massif–a brief description

The northern and western parts of the Adrar Souttouf Massif are covered by undeformed Early Cretaceous to modern siliciclastic sedimentary rocks and sediments that are partially calcified and that lie unconformably above the pre-Mesozoic rocks (Bronner et al., 1985; Leprêtre, 2015; Marchand et al., 1983; Quiroga, 1886, 1889; Rjimati et al., 2011). Pre-Cenozoic siliciclastic (meta-) sedimentary rocks, i.e. silt- and sandstone, quartzite, phyllite, conglomerate, etc., are widespread, but are often scattered all over the working area (Arribas, 1968). Carbonate rocks are very scarce. Lacking fossils and age determinations of intrusions

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