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The Sanandaj–Sirjan Zone in the Neo-Tethyan suture, western Iran: Zircon U–Pb evidence of late Palaeozoic rifting of northern Gondwana and mid-Jurassic orogenesis

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ABSTRACT

The Zagros Orogen, marking the closure of the Neo-Tethyan Ocean, formed by continental collision beginning in the late Eocene to early Miocene. Collision was preceded by a complicated tectonic history involving Pan-African orogenesis, Late Palaeozoic rifting forming Neo-Tethys, followed by Mesozoic convergence on the ocean's northern margin and ophiolite obduction on its southern margin. The Sanandaj–Sirjan Zone is a metamorphic belt in the Zagros Orogen of Gondwanan provenance. Zircon ages have established Pan-African basement igneous and metamorphic complexes in addition to uncommon late Palaeozoic plutons and abundant Jurassic plutonic rocks. We have determined zircon ages from units in the northwestern Sanandaj–Sirjan Zone (Golpaygan region). A sample of quartzite from the June Complex has detrital zircons with U–Pb ages mainly in 800–1050 Ma with a maximum depositional age of 547 ± 32 Ma (latest Neoproterozoic–earliest Cambrian). A SHRIMP U–Pb zircon age of 336 ± 9 Ma from gabbro in the June Complex indicates a Carboniferous plutonic event that is also recorded in the far northwestern Sanandaj–Sirjan Zone. Together with the Permian Hasanrobat Granite near Golpaygan, they all are considered related to rifting marking formation of Neo-Tethys. Scarce detrital zircons from an extensive package of metasedimentary rocks (Hamadan Phyllite) have ages consistent with the Triassic to Early Jurassic age previously determined from fossils. These ages confirm that an orogenic episode affected the Sanandaj–Sirjan Zone in the Early to Middle Jurassic (Cimmerian Orogeny). Although the Cimmerian Orogeny in northern Iran reflects late Triassic to Jurassic collision of the Turan platform (southern Eurasia) and the Cimmerian microcontinent, we consider that in the Sanandaj–Sirjan Zone a tectonothermal event coeval with the Cimmerian Orogeny resulted from initiation of subduction and closure of rift basins along the northern margin of Neo-Tethys.

1. Introduction

Tethys was the major triangular-shaped ocean between Eurasia and Gondwana that existed in the Palaeozoic to Cenozoic and was characterised by ribbon-like continental fragments such as Cimmeria, which rifted away from the northern margin of Gondwana to form Neo-Tethys in the Permian–Triassic (Şengör, 1984; Ricou, 1994; Stampfli and Borel, 2002). In northern Iran, the Palaeo-Tethyan suture is along the Alborz and Kopet Dagh mountain ranges (Figs. 1, 2) and formed by collision of the Cimmerian continental fragment to the Turan platform of Eurasia in the Late Triassic to Early Jurassic Cimmerian Orogeny (Şengör, 1984; Stampfli and Kozur, 2006; Wilmsen et al., 2009; Zanchi et al., 2015). In southwestern Iran, the Neo-Tethyan suture is along the Main Zagros Thrust in the Zagros Mountains (Zagros Orogen) (Fig. 2), and formed by continental collision in either the late Eocene (Allen and Armstrong (2008) or Oligocene (McQuarrie and van Hinsbergen, 2013). Northeast of the suture is the Sanandaj–Sirjan Zone that consists of basement metamorphic, igneous and sedimentary rocks, interpreted to form the southwestern margin of the Cimmerian continental fragment (Şengör, 1984; Ricou, 1994; Stampfli and Borel, 2002).

The Sanandaj–Sirjan Zone contains scattered elements of Pan-African basement that is widely developed in parts of Iran and Turkey (Hassanzadeh et al., 2008; Nutman et al., 2014). Sparse Late Carboniferous and Permian igneous activity has been more widely reported within the Sanandaj–Sirjan Zone (Figs. 2, 3) and these include A-type plutons south of Lake Urumieh (315 ± 2 Ma; Bea et al., 2011), adjacent to Lake Urumieh (320–317 Ma; Moghadam et al., 2015) and farther southeast in the Golpaygan region (288 ± 4 Ma; Alirezaei and Hassanzadeh, 2012). The Carboniferous–Permian igneous activity preceded and accompanied rifting of the Cimmerian continental fragment away from the northern margin of Gondwana from the Permian onwards

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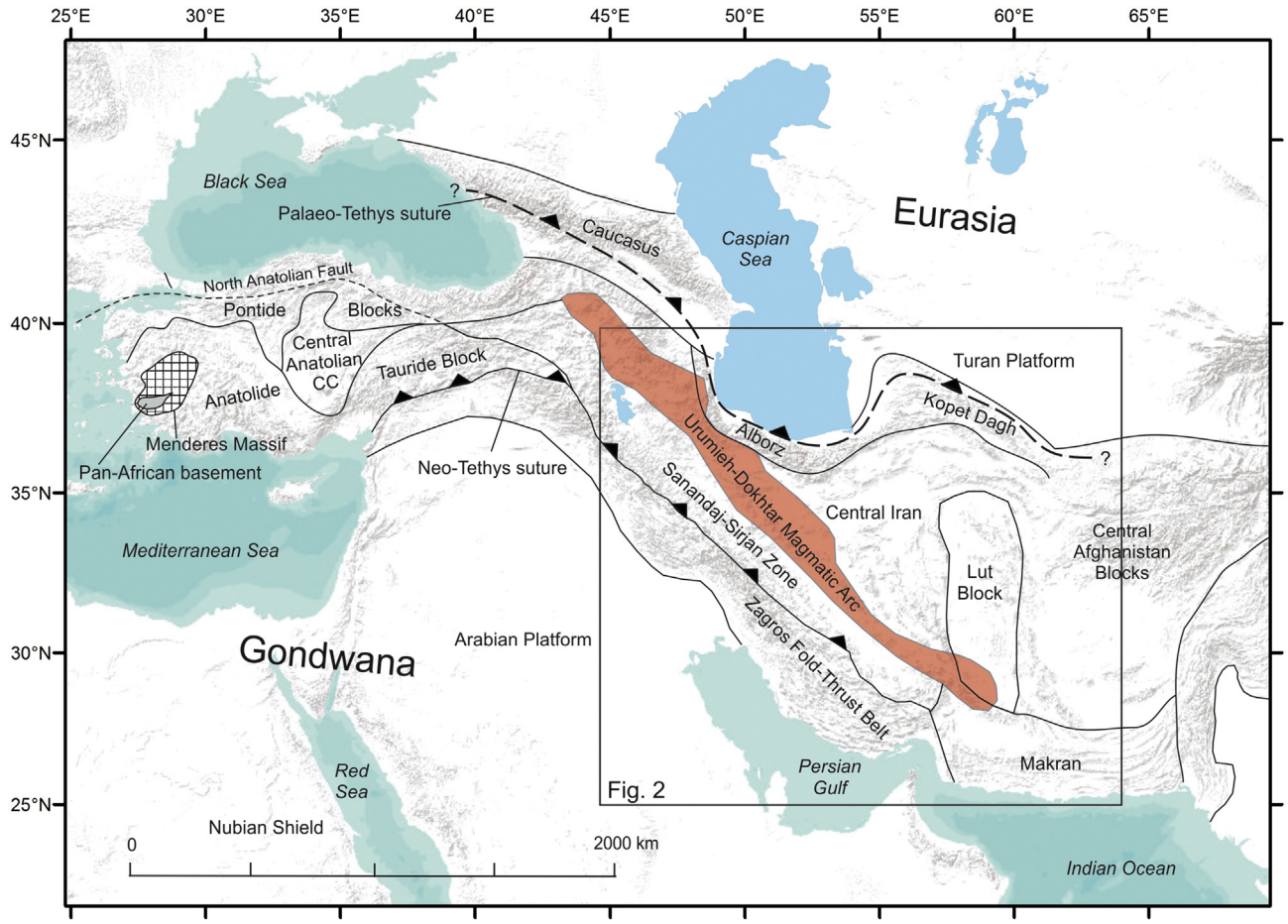

Fig. 1. Map showing the Palaeotethyan and Neotethyan sutures with the Cimmerian continent between Gondwana and Eurasia in the Middle East. Location of Fig. 2 indicated. Topography is from Environmental Systems Research Institute (ESRI, Redlands, California) public domain data. Abbreviation: Central Anatolian CC—Central Anatolian Crystalline Complex.

(Şengör, 1984; Stampfli and Borel, 2002; Mohajjel et al., 2003; Agard et al., 2011; Alirezaei and Hassanzadeh, 2012; Moghadam et al., 2015; Shakerardakani et al., 2015; Hassanzadeh and Wernicke, 2016).

We present new U–Pb zircon ages from the June Complex and related units in the northwestern part of the Sanandaj–Sirjan Zone (Fig. 2), with the aim of clarifying the evolution of the June Complex and Hamadan Phyllite. We find that the June Complex formed from latest Neoproterozoic to Triassic protoliths, and was subsequently deformed and metamorphosed in the mid-Jurassic Cimmerian Orogeny. We also dated zircons from the Hamadan Phyllite to test this idea. We explore the significance of these results for the setting of the Sanandaj–Sirjan Zone in the Palaeozoic and its roles in the Cimmerian continental fragment and subsequent involvement in tectonic events.

2. Geological setting

2.1. Zagros Orogen and the Cimmerian continental fragment

The Zagros Orogen in southwestern to northwestern Iran is divided by the Main Zagros Thrust into the Sanandaj–Sirjan Zone to the northeast and the Zagros Fold and Thrust Belt to the southwest (Alavi, 1994; Agard et al., 2011). The Sanandaj–Sirjan Zone consists of metamorphic, igneous and sedimentary units of late Neoproterozoic to Neogene age in the hanging wall of the Main Zagros Thrust (Alavi, 1994; Mohajjel et al., 2003; Agard et al., 2005, 2011; Mohajjel and Fergusson, 2014; Mehdipour Ghazi and Moazzen, 2015; Shakerardakani et al., 2015; Sheikholeslami, 2015). The Zagros Fold and Thrust Belt has a Phanerozoic succession deformed during the late Eocene to present continental collision between Eurasia and the Arabian continent (Hessami et al., 2001; Alavi, 2004). Associated with the northeast-dipping Main Zagros Thrust are Cretaceous ophiolites, Mesozoic limestones and radiolarites, along the suture between the northwestern Arabian margin and the Sanandaj–Sirjan Zone (Mohajjel et al., 2003; Agard et al., 2005, 2011; Moghadam and Stern, 2011). Abundant Eocene volcanic rocks of the Urumieh–Dokhtar Magmatic Arc occur northeast of the Sanandaj–Sirjan Zone (Fig. 2) and reflect subduction of Neo-Tethyan oceanic crust prior to collision (Alavi, 1994; Agard et al., 2011; Verdel et al., 2011). Volcanic rocks of a similar age are widely distributed throughout most of the rest of Iran east and north of the Urumieh–Dokhtar Magmatic Arc (Verdel et al., 2011).

The Sanandaj–Sirjan Zone has been interpreted as the southwestern fringe of the Cimmerian continental fragment (Şengör, 1984; Ricou, 1994; Stampfli and Borel, 2002). However, the idea of a single Iranian Cimmerian continent requires reassessment, given evidence for Late Palaeozoic and Triassic to mid-Jurassic events within it. The Triassic–Jurassic Palaeo-Tethyan suture has been identified within the Yazd Block of Central Iran (Fig. 2); well south of the main strand of the suture in the Alborz and Kopet Dagh mountains (Bagheri and Stampfli, 2008). Carboniferous accretion (Variscan) at the northern margin of Palaeo-Tethys, prior to the collision within the Yazd Block, has been determined from radiometric ages on metamorphic rocks (Bagheri and Stampfli, 2008; Zanchi et al., 2009, 2015). Palaeomagnetic data show that the various blocks of Central Iran have undergone considerable counter-clockwise rotations in the Late Jurassic and Neogene so that their present-day configuration differed considerably to that in the Palaeozoic and early Mesozoic (Mattei et al., 2012, 2015).