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Magmatic evolution and crustal growth of the Mediterranean region: New geochemical and geochronological perspectives

The Mediterranean region and Anatolia in particular exhibit significant geological evidence for the magmatic and tectonic evolution of the Neotethyan oceanic realm, which existed between the Gondwana and Eurasia supercontinents during the Mesozoic and early Cenozoic. The Neotethyan domain consisted of a series of nearly E–W–trending seaways, separated by ribbon continents of West–Gondwana origin (Fig. 1). The opening and closure of the Neotethyan seaways were strongly controlled by the relative motions of Afro–Arabia with respect to the North–South America continents, first to the east–southeast and then to the northeast, respectively. Time–progressive collapse of the Neotethyan ocean basins in front of the NE–moving Gondwana-derived crustal ribbons resulted in several continental collision events during the Mesozoic to Cenozoic, which produced the Anatolian mountain belts within the broader Alpine–Himalayan orogenic system.

This young orogenic system, which is still tectonically and magmatically alive with active plate interactions and intra-continental deformation, constitutes one of the best natural laboratories in the earth to examine different modes and tempos of crustal growth processes. Recent field–based systematic geochronological, geochemical, and petrological studies of the Tethyan ophiolites and late Mesozoic–Cenozoic extrusive and intrusive rock sequences in this region have shed much light on our understanding of the mantle dynamics, melt evolution, and crustal deformation during the rift–drift, seafloor spreading, and subduction, collision and accretion-related tectonic stages of the Tethyan evolution. The Mediterranean region makes up an important geographic and geologic sector within the Alpine–Himalayan orogenic system, linking the crustal and landscape evolution of East Asia to that of Europe as a tectonic bridge.

In this special issue, we assemble twenty-nine contributions (Fig. 1) presenting an overview of the petrology, geology, and metallogeny of the Eastern Mediterranean region. We thank the Editor-in-Chief, Prof. Mei-Fu Zhou and Editorial Assistant, Dr. Diane Chung of the Journal of Asian Earth Sciences and in particular all the reviewers who put their efforts in providing valuable and critical comments on the manuscripts and tremendously helped improve our entire effort to bring this Special Issue into publication. We express our great appreciation to the authors of the papers for their contributions.

[1] Öztürk et al. (2020) studied the Kestanbol Magmatic Complex (KMC) on the Biga Peninsula (NW Turkey) with regard to its geochemistry and U-Pb zircon ages. They dated the complex at 22.24–19.33 Ma and suggest that KMC was formed by differentiation of mantle-derived mafic melts via assimilation of ancient continental materials coupled with mineral fractionation.

[2] Jing et al. (2018) reports in-situ Li concentrations and isotopic compositions of olivine, clinopyroxene and orthopyroxene along with major element compositions of minerals, and whole-rock trace element compositions of the mantle xenoliths composed of refractory harzburgites with subordinate lherzolites and olivine-websterite from the Tethys orogenic belt in NW Turkey to investigate the metasomatic overprints in the mantle xenoliths. The authors suggest subduction-related metasomatism considering the non-depleted whole-rock light rare earth element patterns and enrichment in large ion lithophile elements, while the Y-depletion was suggested to be the derivation of the metasomatic melts/fluids from a garnet-bearing source. Although the minerals from all the xenoliths display homogeneous major element composition, they show large intra- and inter-mineral Li elemental and isotopic variations. The correlation between δ^7Li values and the forsterite contents of olivines, along with the preferential uptake of Li in pyroxenes, and the presence of light Li isotopic compositions in the cores of pyroxenes, indicate the influence of silicate melt-rock interaction. The authors interpret these results as evidence for a metasomatic overprint predating the zonation in the Tethys orogenic belt of NW Turkey. Thus, both the recent fluid metasomatism and earlier silicate melt metasomatism were suggested to be strongly related with the successive subduction of the Tethyan oceanic plate.

[3] Ünal et al. (2019) presents field, geochronology and geothermobarometry results of the Solarya Pluton (SP) from NW Turkey in order to better understand its emplacement into the different levels of the crust. The authors suggest that the K-feldspar megacrystalline granodiorite (^{40}Ar/^{39}Ar – 23.2 Ma, U-Pb – 21.8 Ma) began its emplacement forcefully in the relatively deeper levels of the crust and after this stage, microgranite-granodiorite (^{40}Ar/^{39}Ar – 22.6 Ma, U-Pb – 21.2 Ma) was passively emplaced into the shallow levels via cauldron subsidence and in the latter stages the haplogranite (^{40}Ar/^{39}Ar – 21.6 Ma) was emplaced into the ring faults at 1.5 km depth. They conclude that the forceful to passive emplacement of the SP into the upper crust occurred under Aegean extensional tectonics.

[4] Ünal and Altunkaynak (2019) targets Solarya Volcano-plutonic complex (SVPC) as a major volcano-plutonic complex located in NW Turkey to evaluate magma chamber processes and mantle-crust interactions in lithospheric scale by using major-trace element geochemistry, Sr-Nd-Pb isotope geochemistry and new ^{40}Ar/^{39}Ar geochronology. Enriched mantle (EMII) or sub-continental lithospheric mantle source with crustal contribution of about 25–45% was suggested by the authors. They conclude that the early Miocene SVPC was developed under syn-convergent, extensional regime concurrent with the exhumation of other major volcanoplutonic and core complexes (eg. Kozak, Menderes, Kazdağ, Çataldağ) in NW Anatolia.

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[5] Akal (2019) dated the NW-SE elongated andesitic exogenous composite Ildır lava dome from the Karaburun Peninsula, located within the Izmir-Balıkesir Transfer Zone, western Anatolia, at 16.39 ± 0.34 Ma. The author suggests that Ildır lava dome was controlled by fissure-like volcanic activity along multiple fault lineaments as a result of extensional duplex–negative palm-tree lineaments which are related to the Miocene NW-SE directed sinistral strike-slip transtensional fault zone of the Karaburun peninsula. He concludes that the parental magma which formed the lava dome was generated by partial melting of a highly contaminated mantle source which had been modified by subduction-derived fluid/melt components, and the melts were subsequently differentiated by fractional crystallization and crustal assimilation processes in the crust.

[6] Kamacı and Altunkaynak (2019) presents mineral compositional, petrography and crystal size distributions data on the Early Miocene basaltic andesite and andesite from the Kepsut Volcanic Complex (KVC), NW Turkey. The authors suggest that the magma evolution of KVC occurred in four stages: (I) Near-Equilibrium Stage, (II) Mafic Input Stage, (III) Mixing/Mingling Stage and (IV) Pre-eruption Stage. Combined petrography, mineral chemistry and geothermometry studies on KVC rocks indicate that mixing/mingling processes and subsequent decompression-driven crystallization were the principal mechanisms for the origin of the textural and mineralogical diversity that is characteristic of KVC. The authors conclude that disequilibrium crystallization was probably caused by the influx of a hotter basaltic magma into crustal magma chambers during the first major period of north–south extension in western Anatolia.

[7] New geochemical and U-Pb zircon geochronological data were presented by Aysal et al. (2018) for the Kırklareli (268.3 ± 2.1 Ma), Tepecik (249.4 ± 1.5) Ma and Sancaktepe plutons (253.7 ± 1.8 Ma) from the western Pontides, Turkey. Considering the enrichment in large ion lithophile and light rare eath elements, and depleted high field strength elements contents of the plutons, the authors suggest mafic crustal sources for the melts from which the plutons formed. They also conclude that the Kırklareli pluton was generated in a subduction-related magmatic arc, and the highly fractionated Sancaktepe and Tepecik plutons were formed in a back-arc setting in response to the northward subduction of the Paleo-Tethys Ocean during the Mid Permian–Early Triassic.

[8] Özyurt and Altunkaynak (2020) focuses on adakitic porphyries, which are rare and recently discovered in the northwest (NW) Turkey, by presenting a comprehensive dataset including petrography, geochemistry, and $^{40}Ar/^{39}Ar$ geochronology. The authors suggest that the adakitic magmatism was not formed above an actively dehydrating subducted slab; rather, geochemical characteristics of the adakitic porphyries are consistent with magmatism that is more typical of intraplate tectonic settings. The authors infer that upwelling of the asthenospheric mantle as a result of steepening and breaking of the subducted Tethyan oceanic slab or partial delamination of the base of the lithosphere raised the geothermal gradient beneath the suture zone and increased heat flow to trigger the generation of K-rich C-adakite magmas in NW Turkey during the early Eocene.

[9] Güraslan and Altunkaynak (2019) provides new mineral chemistry and major-trace element and Sr-Nd-Pb-O isotope data as well as detailed field and petrographic observations from the Topuk Pluton (TP; ca. 48 Ma) and its hypabyssal counterparts. Geothermobarometry calculations and field observations suggest that TP is a shallow level intrusion. Geochemical studies revealed that the TP magma originated from enriched mantle II (EMII) with contribution from the lower crust. The results of numerical modeling of the authors indicate lower crustal input of 5 to 20%. The authors conclude that the Eocene melt generation was most probably caused by the upwelling asthenosphere due to the break-off of Neo-Tethys slab in NW Anatolia.

[10] Erkül et al. (2019) provides geological, petrographical and whole-rock geochemical, and Sr–Nd isotopic data from the Middle Miocene alkaline Yağcıköy Volcanic Complex that can be considered as

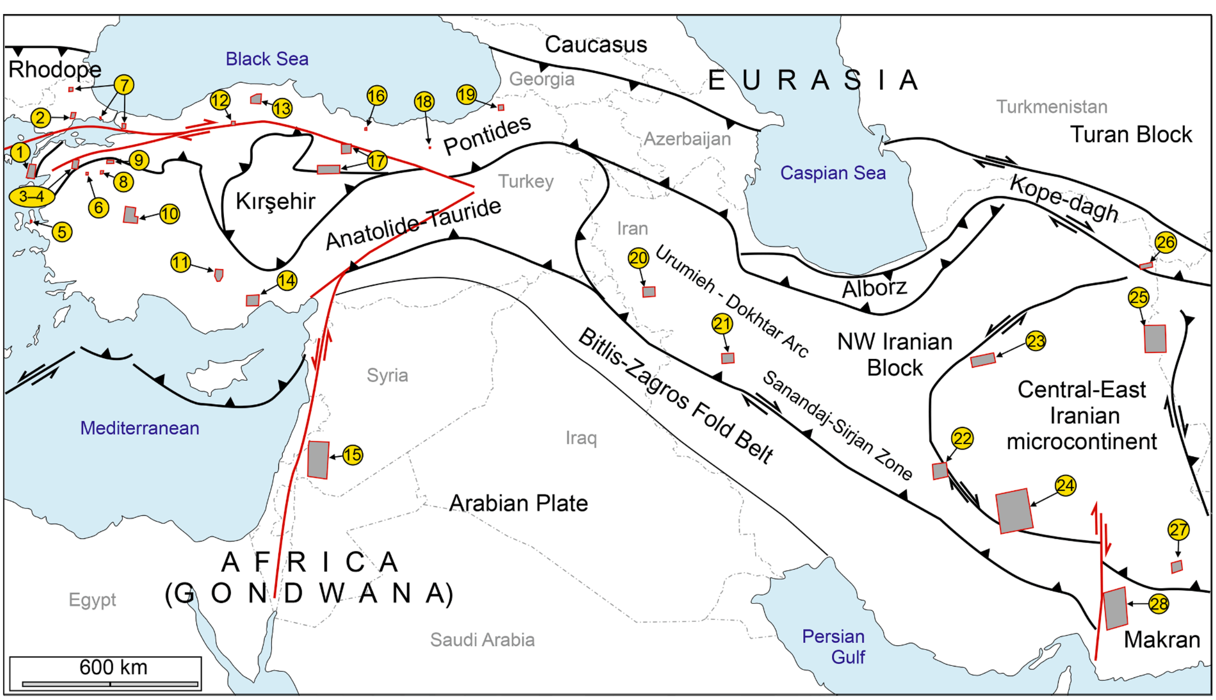

Fig. 1. Simplified map of the Eastern Mediterranean showing the main suture zones and tectonic units with major fault zones (compiled from Tadayon et al., 2017; Okay and Tüysüz, 1999, and the papers in this issue). The locations of the studies of this special issue are also shown. [1] Öztürk et al. (2020); [2] Jing et al. (2018); [3] Ünal et al. (2019); [4] Ünal and Altunkaynak (2019); [5] Akal (2019); [6] Kamacı and Altunkaynak (2019); [7] Aysal et al. (2018); [8] Özyurt and Altunkaynak (2020); [9] Güraslan and Altunkaynak (2019); [10] Erkül et al. (2019); [11] Çoban et al. (2020); [12] Di Rosa et al. (2019); [13] Gücer et al. (2019); [14] Saka et al. (2019); [15] Ismail et al. (2020); [16] Temizel et al. (2019); [17] Göçmengil et al. (2019); [18] Karsli et al. (2020); [19] Aydin et al. (2020); [20] Mazhari et al. (2020); [21] Azizi et al. (2020); [22] Maleki et al. (2019); [23] Shirdashtzadeh et al. (2018); [24] Kheirkhah et al. (2020); [25] Jentzer et al. (2020); [26] Ghavi et al. (2018); [27] Ghalamghash et al. (2019); [28] Barbero et al. (2020).

early products of high-K shoshonitic and ultrapotassic volcanic system linked to the slab-tear processes in western Turkey. Domes, dykes, lava flows and associated volcaniclastic rocks intercalated with Middle Miocene fluvial/lacustrine deposits were suggested to have occurred on the off-axis of a rift environment and have similar geochemical patterns to each other. The Yağcıdağ volcanic complex was suggested to have formed by chemically normal zoned magma chamber that have undergone significant fractionation processes. The authors documented a model for the evolution of spinel peridotite-bearing, strongly metasomatized lithospheric mantle source linked to the upwelling of hot asthenospheric melts through a tear on the subducted slab.

[11] Çoban et al. (2020) reports a data set of K-Ar age, Sr-Nd-Pb isotopic and geochemical data from the Karadağ stratovolcano (KS) to understand the spatiotemporal association between adakitic and mafic potassic (absarokitic-shoshonitic-banakitic) magmas in a post-subduction intracontinental setting in Central Anatolia, Turkey. The authors propose that KS was built up by the eruption of adakitic andesites (825 ± 17 ka), absarokite-shoshonites (393 ± 153 ka), adakitic dacites (45 ± 6 ka) and effusive deposits (<45 ka). They also suggest that absarokitic magmas were derived from the lowermost lithospheric mantle source and adakitic magmas from the uppermost mantle lithosphere, and the thermal energy required for partial melting of the metasomatized mantle lithosphere was generated by upwelling of the hot asthenosphere through deep strike-slip faults bordering a pull-apart basin in a post-subduction extensional intracontinental setting. The authors conclude that a post-collisional transtensional stage after rapid multi-phased uplift was triggered by asthenospheric mantle flows, transferring the metasomatized mantle-derived magmas into the crust system along with the whole Cappadocian Volcanic Province in Central Anatolia, Turkey.

[12] Di Rosa et al. (2019) investigated the thick succession of the Early Maastrichtian-Middle Paleocene Taraklı Flysch in the Boyalı area (northern Anatolia) which represents a foredeep sediment deposited during the final stage of collision between the Sakarya and Istanbul-Zonguldak continental margins, developed as a consequence of the closure of the Intrapontide oceanic basin. They dated one of the side-blocks (quartz monzonite to leucocratic granodiorites), located at the top of the Taraklı Flysch, as Late Permian and suggest that the source area of these granitoids can be identified in the Istanbul-Zonguldak terrane. The authors conclude that the coarse-grained deposits of the Taraklı Flysch were supplied by an orogenic wedge, consisting of oceanic units topped by the Istanbul-Zonguldak terrane.

[13] Gücer et al. (2019) reports new petrological, petrochemical and ^{40}Ar-^{39}Ar radiometric age data from the Devrekani paragneisses (N Turkey), and provide new constraints on the timing of the metamorphism. They suggest that the paragneisses, derived from shale-wackestone and pelitic sedimentary protoliths, have typical rock lithologies of an active continental margin, and the peak metamorphism took place during the Middle–Upper Jurassic period (ca. 174–156 Ma), suggesting that the metamorphic rocks cooled to 300–350 °C at ca. 156 Ma. They conclude that the Devrekani Massif represents the products of pre-Jurassic sedimentation, and Permo-Carboniferous continental arc magmatism, overprinted by Jurassic metamorphism.

[14] Saka et al. (2019) reports geochemical data on the ophiolitic rocks and chromitites from the Mersin ophiolite, S Turkey. Considering the concave chondrite-normalized REE patterns and medium- to high-Cr# spinel, mantle peridotites were suggested to have re-fertilized by boninitic melts from which the chromitites formed. The authors detected PGM assemblage of laurite and Os-Ir alloys in chromitite and used this observation to suggest that chromitites were crystallized within a range of low fS_2 conditions ($logfS_2 \sim -2$ to -1.3) and a Tmax of ~1200 °C. Tholeiitic basalts from the Mersin ophiolite were interpreted to be the product of 20% melting of a spinel-bearing asthenospheric mantle, and the alkali basalts, which have similar trace element patterns to OIB, were suggested to have an origin unrelated to that of the ophiolite assemblage. The authors propose the following tectono-magmatic model for the petrogenetic evolution of the Mersin ophiolite: i) oceanic ridge spreading generated MORB type magmas, (ii) melting of deep mantle sources beneath MORB type crust generated OIB-like basalts in Neo-Tethyan oceanic basin, (iii) subduction initiation and formation of an infant forearc basin formed island arc tholeiites and boninites.

[15] Ismail et al. (2020) reports sapphirine coronas around spinel in spinel-garnet–bearing websterite xenoliths from the Cenozoic alkali basalts of Jabel El Arab, the southern extremity of the Syrian Rift. The authors divided the full pyroxenite suite into two groups: (A) tholeiitic to transitional deep magmatic cumulates originated from a depleted mantle source, (B) deep magmatic cumulates that crystallized under HP-HT conditions from liquids of alkaline affinity. The authors propose that tholeiitic-transitional and alkaline magmas were underplated below or intruded at the base of a thinned Syrian crust in response to Mesozoic rifting and magmatism beneath the Arabian Plate and the eastern Mediterranean region.

[16] Temizel et al. (2019) studied the Late Cretaceous syenitic plutons, intruded into the Late Cretaceous volcanics and volcanoclastics, in the Ordu area from the Eastern Pontides orogenic belt of Turkey. These plutons were suggested to be I-type, metaluminous-peraluminous transitional and shoshonitic in character, and dated at 78.5–72 Ma by the authors. The authors propose that the investigated syenitic plutons were formed in an extensional continental arc setting triggered by slab roll-back, and the parental magma of these plutons was derived from melts of lower crustal materials (metabasalt/metaandesite) and lithospheric mantle component.

[17] Göçmengil et al. (2019) gives new ^{40}Ar-^{39}Ar ages, mineral chemistry and petrological data from the northern (Almus) and southern portion (Yıldızeli) of the İzmir-Ankara-Erzincan Suture zone to evaluate the characteristics of the enigmatic early Cenozoic magmatism in northern Anatolia. The authors report that magmatism confined in a narrow range (44.4–44.8 Ma) which were constrained by Ar-Ar geochronology and stratigraphy. The authors differentiated two main series with different sub-series (V1a, V1b, V2a, V2b) that display the volcano-sedimentological evolution of the magmatism. Geochemical modeling derived from the most basic members and rare cumulate xenolith from the volcanic units indicate that the source of the volcanism derived from amphibole and clinopyroxene bearing spinel-peridotitic mantle region that sided in lithospheric depths. The authors display that the shallow magma chamber processes of the volcanism mainly shaped by fractional crystallization, magma mixing and assimilation, and suggest that the triggering of the volcanism across the region governed by the thinning of the lithospheric mantle by post-collisional tectonic re-organization of the lithospheric mantle beneath suture zone.

[18] Karsli et al. (2020) presents the U-Pb LA-ICP-MS age, Sr-Nd isotopic and geochemical data of the Kov quartz diorite porphyries (KQDP) from the Sakarya Zone of the NE-Turkey with aiming to limit the timing of the initiation of the break-off of the northern branch of the Neotethyan oceanic lithosphere. The authors report that KQDP is of ~50 Ma, and was likely crystallized from the melt that originated from an EM2-type spinel-facies subcontinental lithospheric mantle (SCLM), followed by the fractionation with insignificant crustal assimilation. Considering previous and their own data as well as geological background, the authors propose that the generation of the KQDP resulted from the slab break-off event that caused ascending or infiltration of hot asthenosphere. Such sporadic occurrences of the KQDPs were suggested to be likely associated with the onset of extensional tectonics due to the earlier stage of slab break-off along the Sakarya Zone throughout the early Eocene period.

[19] Aydin et al. (2020) reports that the subduction related Late Cretaceous Artvin volcanic rocks (LCAVs) from the eastern Sakarya zone (ESZ) of NE Turkey, showing a wide compositional spectrum ranging from tholeiite to calc-alkaline/shoshonite, occurred in two successive stages that took place during the northward subduction of the northern

Neotethys Ocean (NNO): (i) first stage (S1: Turonian–Early Santonian) and (ii) second stage (S2: Late Santonian–Campanian), and are composed of mafic/basaltic (S1-Çatak and S2-Çağlayan) and felsic/acidic (S1-Kızılkaya and S2-Tirebolu) rock types. They conclude that the parent magmas of the S1-Çatak and S2-Çağlayan mafic volcanic rocks were derived from underplated basaltic melts that originated by partial melting of metasomatized spinel lherzolite and spinel-garnet lherzolite, respectively whereas the compositions of the S1-Kızılkaya and S2-Tirebolu felsic rocks were particularly controlled by metasomatized mantle–crust interaction and MASH zone + shallow crustal fractionation processes.

[20] Mazhari et al. (2020) studied the Pasveh pluton in the northwestern part of the Sanandaj-Sirjan Zone (SSZ), NW Iran that shows the granitic outcrops with three discrete geochemical signatures: mesocratic granitoid, felsic monzogranites, and leucocratic granitoid dikes. The authors suggest that the mesocratic granitoids were likely generated by the partial melting of meta-igneous crustal rocks with mantle-like isotopic ratios whereas the felsic monzogranites, with enriched Sr-Nd isotopes, were likely derived by partial melting of lower to middle crust that is comprised of metasedimentary and juvenile meta-igneous rocks. They propose that the leucocratic granitoid dikes, showing adakitic composition, possibly were derived by partial melting of subducted oceanic crust under high-pressure conditions. The authors conclude that the closing of the Neo-Tethys in NW Iran occurred during the Early-Middle Eocene but before the emplacement of the poly-phase Pasveh pluton.

[21] Azizi et al. (2020) studied the intrusive bodies in central part of the Sanandaj-Sirjan zone in southern Ghorveh, western Iran, and dated them by zircon U-Pb geochronology at 154–146 Ma. The authors suggest that magma differentiation and mixing formed different magmatic rocks that range from gabbro to granite, and ocean island basalt-like melt was involved in the enrichment of LILEs and LREEs. They also suggest that the depleted mantle melts, with a minor crustal contribution, accelerated the thinning of the continental crust in an extensional regime during the Jurassic. They conclude that this rifting was responsible for the sequential injection of mafic magma with a wide range of magma mixing and mingling in southern Ghorveh during the Late Jurassic.

[22] Maleki et al. (2019) dated the granitoids between 31.23 and 29.49 Ma, and discussed their genetic linkage with the associated skarn-type iron deposits from the Khak-Sorkh area in the central Urumieh-Dokhtar magmatic arc (UDMA), Iran. Due to the common occurrence of hydrous minerals, serpentine, and phlogopite, closely associated with magnetite, the authors suggest that the ore formation in the Khak-Sorkh deposit occurred during retrograde skarn reactions. They propose that the age relationships and the Pb isotope data for epidote and calcite from various rocks support a link between intrusive processes and development of calc-silicate assemblages and iron ore in the Khak-Sorkh area of UDMA.

[23] Shirdashtzadeh et al. (2018) presents petrographic and U-Pb LA-ICP-MS isotopic data from the single peraluminous intrusion (alkali-feldspar granite of Airekan) with partial gneissic foliation on the north western margin of the Yazd Block in the west of the Central-East Iranian Microcontinent (CEIM) to discuss the evolution of this terrain. The authors report that Airekan granite is of Lower Ordovician age (~483 ± 2.9 Ma) with a distinctive inherited component at ~518.2 ± 4.9 Ma, likely to be ultimately sourced from neighboring leucogranite terrains. They suggest that zircons with ~382.6 Ma indicate extensive dynamic recrystallization and development of a partial gneissic foliation at amphibolite facies metamorphism during the Paleo-Tethys evolutions in the southern active margin of Eurasia. The authors also suggest that the Airekan, and possibly the whole of the northern Yazd Block, has been at upper crustal levels ever since the middle Jurassic, possibly recording extension and exhumation associated with Gondwana breakup.

[24] Kheirkhah et al. (2020) provides new analyses for domes and lavas from near Dehaj, SE Iran. The authors state that they show two distinct compositional series. One contains medium-K domes showing high-silica adakite affinity and the other serie has high-K affinity and includes both lavas and dome. Given its geochemical signatures and non-relationship with the more mafic, mantle-derived high-K series, they consider that the adakite serie was derived from melting of eclogitized mafic lower crust. The high-K serie relates to dehydration melting of deeper mantle. They also explored adakitic rocks across Iran and their relationship to porphyry copper deposits, and suggest that at Dehaj and several other Iranian centers, adakites are chemically controlled by garnet as a source or fractionating phase, and are barren, whereas the presence of amphibole as a key phase seems to correlate with Cu mineralization.

[25] Jentzer et al. (2020) provides geochemical data on the Late Cretaceous (~78 ± 8 Ma) magmatic rocks collected from the eastern side of the Sistan suture zone (E Iran). The authors distinguished two coexisting groups: a low-K calc-alkaline series with basaltic to rhyolitic composition, and calc-alkaline intermediate to felsic samples. They report that the low-K calc-alkaline serie reflects classical arc magmatism formed due to the partial melting of a DMM-like source contaminated by sediment-derived fluids whereas the calc-alkaline intermediate to felsic samples correspond to high-silica adakites. The authors conclude that the Late Cretaceous magmatic arc is associated with NE-dipping subduction of the Sistan ocean below the stretched continental Afghan margin and the emplacement of adakites postdate the formation of the suture zone eclogites by a few Ma at most.

[26] Ghavi et al. (2018) studied the Late Triassic Torbat e Jam stock in NE Iran, which is contemporaneous to Paleozoic ophiolitic outcrops, to constrain the closure of the Paleotethys ocean in the Tethyan orogenic belt in northeastern Iran. The authors state that the investigated three suites from the stock are I-type and metaluminous to moderately peraluminous and show enrichment in LILE, low LREE/HREE fractionation and small negative Eu anomalies. The authors suggest that the Torbat e Jam stock formed in a late orogenic to post-collisional tectonic setting after the closure of a secondary Paleotethys ocean (Paleotethys II), which opened as an oceanic trough during the Late Paleozoic in the Iranian block, and closed in the Late Permian-Early Triassic Indosinian orogeny.

[27] Ghalamghash et al. (2019) reports a magmatic flare-up throughout Miocene to Quaternary in the western segment of the Makran-Chagai arc, SE Iran. The authors envisage that the long-lived magmatic activity was formed by partial melting of an enriched mantle wedge underneath an arc in response to continental subduction event. They also state that the assimilation and crystal fractionation are likely magma evolution processes. Based on previous and their own data, the authors conclude that the style of subduction in the Makran-Chagai arc has experienced little modification since few million years.

[28] Barbero et al. (2020) reinterpreted the Ganj Complex in North Makran domain (southeast Iran) and suggest that Ganj Complex represents remnants of a Turonian-Coniacian volcanic arc that was most likely formed in a relatively shallow marine environment in an extensional intra-arc setting. They, therefore, propose that the Ganj volcanic arc formed in the southern margin of the Lut block as a consequence of north-dipping subduction of the North Makran oceanic basin. They also suggest that this subduction was coeval with the subduction of the southern Neo-Tethys, which was active to the south of the North Makran Ocean.

[29] Förster et al. (2019) experimentally determined the effects of mantle metasomatism on the K-rich lavas. The experiments the authors performed simulate the interaction of refractory lithospheric mantle and metasomatizing melt in a 2-layer reaction experiment. The sediment/dunite reaction experiments lead to formation of a strongly K-enriched phlogopite-pyroxenite layer sandwiched between the two starting materials, and simulates fore-arc environment whereas the hydrous mantle melt/dunite reaction run was simulated by reacting a hydrated basanite with dunite. The authors conclude that the metasomatic enrichment of the mantle lithosphere in K does not need a highly K-enriched metasomatic agent since the enrichment of K within the reaction zone is strongly controlled by the formation of low K/Na and low-K residues.

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