Neoproterozoic structural evolution of SE Sinai, Egypt: II. Convergent tectonic history of the continental arc Kid Group

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Abstract

The Neoproterozoic Kid Group includes volcano-sedimentary sequences deposited in active continental margin back-arc, remnant arc and intra-arc settings. The ENE–WSW to E–W arc trend and arrangement of arc-related basins suggests subduction to the N or NNW. The four stage deformation history (events D1–D4) of the northern Wadi Kid area is described in the companion paper (part I). This contribution (part II) reveals three deformation events (D1–D3) in the southern Wadi Kid area. These three events can be correlated with D1–D3 in the northern Wadi Kid area, with differences in D1–D3 intensity and orientation patterns between the northern and southern areas. In the southern Wadi Kid area D1 probably involved NW-ward thrust stacking of beds with lesser folding effects. D2 structures include gently dipping foliation, semi-recumbent mesoscopic folds, and SSE-vergent thrust faults. D3 is a macroscopic folding event with mainly gentle upright WNW–ESE trending folds. The Quneia Diorite intruded syn-D2 and is also D3 affected. For the Wadi Kid area as a whole, recent workers interpreted D1 as the main crustal thickening event, followed by D2 gravitational collapse, regional extension and core complex exhumation. Our investigation finds both D1 and D2 to be folding and thrusting events (i.e. both convergent tectonic events) that emplaced high T schists in the north over the lower T arc metavolcanics in the south. The core complex and thrust tectonic interpreted models are both consistent with clockwise metamorphic P–T–t histories, however, they have distinct P–T–t–D diagrams.

Keywords: Neoproterozoic continental arc; Arc collision tectonics; Multiple folding and thrusting
Neoproterozoic structural evolution of SE Sinai, Egypt: I. Re-investigation of the structures and deformation kinematics of the Um Zariq and Malhaq Formations, northern Wadi Kid area

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Abstract

The Wadi Kid area of the SE Sinai comprises Neoproterozoic arc metavolcanics and metasediments bordered to the N, W and S by post-kinematic granitoid plutons. The structure and tectonics of the Kid area remain controversial despite more than two decades of investigations. In this study the structural history and characteristics of the northern part of the Kid area (Um Zariq and Malhaq Formations) are described. The earliest tectonic event, D1, produced upright folds with probably originally WNW–ESE trending hinges. The F1 folding weakens to the north. The main deformation, D2, produced regionally penetrative shallow-dipping S2 foliations and semi-recumbent tight to isoclinal F2 folds. S2 cleavage is a product of pure flattening strain that involved pressure solution deformation mechanism, rather than a shear foliation that involved mylonitization as previously reported. Macroscopic F2 folds are dissected by top-to-SSE low-angle thrusts and mylonite zones that emplaced the high T Um Zariq Formation schists over the low-grade metavolcanics in the southern part of the Kid area. The SSE direction of thrusting is parallel to stretching lineations on the S2 cleavage planes. Later folds include D3 WNW–ESE to E–W trending upright gentle folds and D4 upright gentle N–S to NE–SW trending folds. In contrast to the extensional histories recently proposed this study finds the deformation events in the northern Kid area to comprise a compressional folding and thrusting history.

Keywords: Neoproterozoic compressional deformation; Continental arc setting; Fold nappes; Thrusting
Role of fluid mixing and wallrock sulfidation in gold mineralization at the Semna mine area, central Eastern Desert of Egypt: Evidence from hydrothermal alteration, fluid inclusions and stable isotope data

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ABSTRACT

The Semna gold deposit is one of several vein-type gold occurrences in the central Eastern Desert of Egypt, where gold-bearing quartz veins are confined to shear zones close to the boundaries of small granitoid stocks. The Semna gold deposit is related to a series of sub-parallel quartz veins along steeply dipping WNW-trending shear zones, which cut through tectonized metagabbro and granodiorite rocks. The orebodies exhibit a complex structure of massive and brecciated quartz consistent with a change of the paleostress field from tensional to simple shear regimes along the pre-existing fault segments. Textural, structural and mineralogical evidence, including open space structures, quartz stockwork and alteration assemblages, constrain on vein development during an active fault system. The ore mineral assemblage includes pyrite, chalcopyrite, subordinate arsenopyrite, galena, sphalerite and gold. Hydrothermal chlorite, carbonate, pyrite, chalcopyrite and kaolinite are dominant in the altered metaggabro; whereas, quartz, sericite, pyrite, kaolinite and alunite characterize the granodiorite rocks in the alteration zones. Mixtures of alunite, vuggy silica and disseminated sulfides occupy the interstitial open spaces, common at fracture intersections. Partial recrystallization has rendered the brecciation and open space textures suggesting that the auriferous quartz veins were formed at moderately shallow depths in the transition zone between mesothermal and epithermal veins. Petrographic and microthermometric studies aided recognition of CO2-rich, H2O-rich and mixed H2O–CO2 fluid inclusions in the gold-bearing quartz veins. The H2O–CO2 inclusions are dominant over the other two types and are characterized by variable vapor: liquid ratios. These inclusions are interpreted as products of partial mixing of two immiscible carbonic and aqueous fluids. The generally light δ34S of pyrite and chalcopyrite may suggest a magmatic source of sulfur. Spread in the final homogenization temperatures and bulk inclusion densities are likely due to trapping under pressure fluctuation through repeated fracture opening and sealing. Conditions of gold deposition are estimated on basis of the fluid inclusions and sulfur isotope data as 226–267 °C and 350–1100 bar, under conditions transitional between mesothermal and epithermal systems. The Semna gold deposit can be attributed to interplay of protracted volcanic activity (Dokhan Volcanics?), fluid mixing, wallrock sulfidation and a structural setting favoring gold deposition. Gold was transported as Au-bisulfide complexes under weak acid conditions concomitant with quartz–sericite–pyrite alteration, and precipitated through a decrease in gold solubility due to fluid cooling, mixing with meteoric waters and variations in pH and fO2.