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A New Chronostratigraphic Framework for the Paleozoic Strata of Sinai, Egypt, Based on Geochronologic and Thermochronologic Constraints

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ABSTRACT

The Sinai micro-plate has been part of Gondwana since the conclusion of the Pan-African orogeny in the Neoproterozoic. Throughout the Paleozoic Sinai was adjacent to Paleotethys and sedimentary sequences and lithologic assemblages have general affinities with those of North Africa and Arabia. At the northern end of the Gulf of Suez, exploratory wells reveal a total preserved Paleozoic section of ~650 m comprised of roughly equal amounts of carbonate and siliciclastic strata, while in the southern Gulf of Suez and onshore central Sinai the same sequence with a similar total thickness contains very few carbonate units and is dominated by massive, fluvial quartzose sandstone packages.

In the northern Suez region, a thin (~100 m) basal Paleozoic sandstone of imprecise age overlies late Neoproterozoic basement (>580 Ma). The sandstone is disconformably overlain by carbonate and shale-rich marine section of Carboniferous age, based on abundant micropaleontologic evidence. In the central Sinai, the same basal sandstone, is overlain by a major marine incursion marked by laterally extensive carbonate deposition. This marine transgression occurred during the Middle Mississippian (Visean) at ca. 340 Ma and likely only lasted a few million years. Absolute dating of the siliciclastic strata above and below this Visean event has historically been very problematic and chronostratigraphic constraints have largely been based only on ichnofossils, rare stromatolites, and other sparse paleontologic data. Stratigraphic correlations in the pre-Visean sandstones are therefore generally purely lithostratigraphic although an Early Cambrian age is often assigned, given its stratigraphic juxtaposition against late Neoproterozoic basement rocks. For the post-Visean siliciclastic strata, despite more abundant microfossils and palynomorphs, a plethora of contradictory stratigraphic correlation schemes exist and are often based on long-distance constraints. Hence, there is generally no well-defined boundary between the Paleozoic and Mesozoic stratigraphic units.

We have conducted extensive detrital zircon (DZ) U-Pb and (U-Th)/He (ZHe) geo- and thermochronometry and basalt 40Ar/39Ar dating on outcrop samples from Gebels Araba and Samra, along the central Gulf of Suez, and an exploratory well (ERB-B-2X) drilled by Apache Egypt to better constrain the chronostratigraphy of the preserved Paleozoic section in western Sinai. U-Pb crystallization ages confirm that the basement granites in this area were emplaced in late Neoproterozoic times at ~590-560 Ma, similar to other parts of Sinai. ZHe cooling dates show that these rocks were not exhumed until well after 500 Ma, suggesting that most of the Cambrian should be absent. DZHe ages indicate that the oldest sandstones were deposited in the Silurian and were then unconformably overlain by Carboniferous strata. A large part of the post-Carboniferous section previously thought to be Permo-Carboniferous in age, is clearly shown to be Triassic to Jurassic based on detrital ZHe ages. This is confirmed by an 40Ar/39Ar date of 239 Ma (Middle Triassic) from a basalt flow at the base of these units. Our chronostratigraphic interpretation has implications for the tectono-stratigraphic framework, regional correlations of the Paleozoic across NE Africa and Arabia, and the construction of isopach and paleogeographic maps.