3.8 Ga zircons sampled by Neogene ignimbrite eruptions in Central Anatolia

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The Comment of Köksal et al. (2013) is based on a misreading of our article (Paquette and Le Pennec, 2012) and we are afraid that it misses our main point because what they claim was essentially already written in the text.

The main point raised by Köksal et al. is that we have postulated the existence of an Early Archean basement terrane in the lower parts of the Central Anatolian crust. A careful reading of our article clearly demonstrates that we nowhere made such an assertion. Following are a few sentences in which we elaborate on the occurrence of 2.3–3.8-Ga-old zircons:

1) “These … zircon grains … imply the presence at depth of remnants of an Early Archean basement …” (p. 239; remnants means witnesses, not necessarily a terrane);

2) “The absence of ages younger than 2.3 Ga in our zircon population suggests that the Kizilkaya magmas penetrated igneous or metasedimentary Lower Proterozoic and/or Archean terranes” (p. 241; which is only a reasonable assumption);

3) “The origin of these zircon crystals remains poorly constrained. They may derive from an unexposed Lower Proterozoic to Archean basement present at depth …” (p. 241; again, a suggestion, and not an assertion)

4) “The rounded shape of the Archean zircon crystals and the large age range from 2.3 to 3.8 Ga favors a multi-recycled sedimentary origin …” (p. 241; our preferred interpretation).

Consequently, these citations all evidence that these zircons most probably record a long history with multiple episodes of recycling by sedimentary processes. We did not analyze zircon rims, as our main goal was to study the age of the ignimbrite and not the contamination by older rocks. Because our paper was released earlier, we did not refer to the interesting comparison of Lu/Hf signatures of zircons from Anatolian granitoids and Gondwanan sediments by Köksal et al. (2012). Since March of 2012, we completed our data set of Anatolian ignimbrites and found other inherited zircons with ages of 1.8 Ga, 2.0 Ga, 2.3 Ga, 2.7 Ga, and 3.0 Ga, as well as a few zircons of Variscan and Panarfrican ages. In the current state of knowledge, the Köksal et al. suggestion of a Gondwanan origin of these zircons, although plausible, remains highly speculative.

The main question remains the true origin of these zircons, which necessarily derive from a magmatic protolith. In the present knowledge of the oldest terrestrial rocks, the occurrence of rare, and in most cases isolated, detrital zircon grains is not straightforwardly correlated to large continental blocks. As we discussed at the end of our article, the origin of these zircon grains, even at large scale, remains enigmatic. Gondwana, which represents a wide continental domain now scattered from South America to Australia, is a convenient but unsatisfying source.

Assuming that most of the oldest terrestrial crust has been recycled, terranes with >3.8-Ga-old zircon grains are very rare and usually of small size. Consequently, such terranes may occur in many places, including in the deep Anatolian crust. On this point, the arguments of Köksal et al. do not refute the possibility of Early Archean–Lower Proterozoic remnants below central Anatolia.

There is an interesting difference between the mostly Panarfrican ages obtained by Köksal et al. (2012) in zircons recycled into granitoids and the essentially Lower Proterozoic to Archean inheritance peak we document in the Kizilkaya ignimbrite. This argues for different inheritance processes in these two rock types. In many granitoids, inheritance mostly appears in the magma source where basement rocks are partially melted, while mixing, hybridization, and contamination processes are involved in the formation of new magma batches. Zircons are commonly composed of contrasted cores and rims, which record inheritance and the new magma crystallization history. Such processes also occur in magmas feeding ignimbrite eruptions. Nevertheless, the main inheritance is commonly due to the rheological and thermal behaviors of the magma scavenging the wall rock during its ascent to the surface. The 2.3- to 3.8-Ga-old zircon xenocrysts identified in our study occur within a widespread (>10,000 km², >180 km³; Le Pennec et al., 1994) ignimbrite sheet, probably erupted from a narrow (kilometer-scale) vent system. In spite of the vast depositional area of the ignimbrite, magmas feeding the eruption were most likely extracted from a chamber sited in a limited volume in the basement crust. Hence, zircon sources and inheritance-crystallization mechanisms are probably different for these two rock types, and we and Köksal et al. (2012) did not necessarily sample the same geological levels, which translates into dissimilar results and interpretations.

REFERENCES CITED