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Comment on 'Chemical remagnetization of the Upper Carboniferous–Lower Triassic Pyeongan Supergroup in the Jeongseon area, Korea: fluid migration through the Ogcheon Fold Belt' by Y.H. Park, S.-J. Doh and D. Suk

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SUMMARY

A recent paper published in *Geophysical Journal International* reports that the Late Palaeozoic to Early Mesozoic sedimentary rocks in the northeastern Okcheon belt of Korea were remagnetized during the Late Cretaceous to Early Tertiary, and argues that the remagnetization was triggered by fluids travelling more than 800 km from the subducting slab of the Kula/Pacific plates. Based on available geological data, however, we suggest that the remagnetization was caused by thermal effects of a Late Cretaceous pluton intruding the sedimentary rocks and/or associated 'short-range' hydrothermal fluids rather than by 'long-range' fluids.

Key words: Mesozoic magmatism, Okcheon belt, palaeomagnetism, remagnetization, South Korea.

COMMENT

The Okcheon belt (or Ogcheon Fold belt) of South Korea, despite its importance to interpreting the tectonic evolution of east Asia, remains an enigmatic fold-and-thrust belt because its origin and tectonic history are still not well understood (e.g. Chough *et al.* 2000). Palaeomagnetic studies have played a key role in working out the tectonic framework of east Asia (e.g. Zhao & Coe 1987; Enkin *et al.* 1992; Gilder *et al.* 1999). There have been many palaeomagnetic studies also on sedimentary and volcanic rocks of the Okcheon belt of South Korea to aid in the reconstruction of its tectonic movement during the Palaeozoic and the Mesozoic. However, the palaeomagnetic studies particularly for Late Palaeozoic to Middle Jurassic tectonics have not been very successful in Korea, and some studies of the same areas give different results (e.g. Kim & Van der Voo 1990 vs. Doh & Piper 1994, and Uno 1999 vs. Park *et al.* 2003). We believe this is partly due to multiple periods of intense deformation of the Okcheon belt resulting in transposition of sedimentary layers in high strain zones and remagnetization mainly by extensive Mesozoic plutonic activity (Cluzel *et al.* 1990; Chough *et al.* 2000).

Recently, Park *et al.* (2003) presented palaeomagnetic data from Late Palaeozoic to Early Mesozoic sedimentary rocks of the northeastern Okcheon belt, contributing to the palaeomagnetic archives of the Korean peninsula. However, their interpretation of the data is problematic in the geological context, resulting from their oversight of geology and cited literature. We list the points of our argument below:

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(1) Park *et al.*'s (2003) main conclusions are that the Late Carboniferous to Early Triassic sedimentary rocks from the northeastern Okcheon belt were remagnetized during the Late Cretaceous to Early Tertiary and that the remagnetization together with magmatism and mineralization was due to fluids migrating northeastwards more than 800 km from the subducting slab of the Kula/Pacific plates through the fault zones of the Okcheon belt (see their Fig. 13). However, their cause of the remagnetization overlooks several geological features. Firstly, the Korean peninsula was heavily influenced by three periods of Mesozoic magmatism; Triassic (248–210 Ma), Jurassic (197–158 Ma) and Late Cretaceous to Early Tertiary (110–50 Ma) (Sagong *et al.* 2003). These Mesozoic magmatic periods were accompanied by the formation of hydrothermal vein deposits of gold and silver (Shelton *et al.* 1988; Choi 2002; Choi *et al.* 2003). If the fluids migrating northeast from the subducting slab induced the Late Cretaceous to Early Tertiary magmatism and gold/silver mineralization in South Korea, then there should be a systematic variation in the ages of the Late Cretaceous/Early Tertiary plutons and mineral deposits (i.e. older toward northeast). However, such a pattern in the ages of the plutons and mineral deposits does not exist (Choi 2002; Choi *et al.* 2003; Sagong *et al.* 2003). Secondly, we cannot understand why the fluids should have been generated only in the southwestern portion of the subducting slab (see fig. 13a of Park *et al.* 2003) and selectively entered the northeast-striking fault zones from the southwestern tip of the Korean peninsula. Furthermore, these fault zones are believed to extend southwestwards to the East China Sea as well as northeastwards to Sikhote Alin across the East Sea or Japan Sea (Cluzel *et al.* 1991; Otsuki 1992; Lee 1999). Thirdly, thermal metamorphism and hydrothermal alteration are common in the intruded rocks around the Late Cretaceous/Early Tertiary plutons (e.g. Shelton *et al.* 1988; Park & Park 1990; Lee

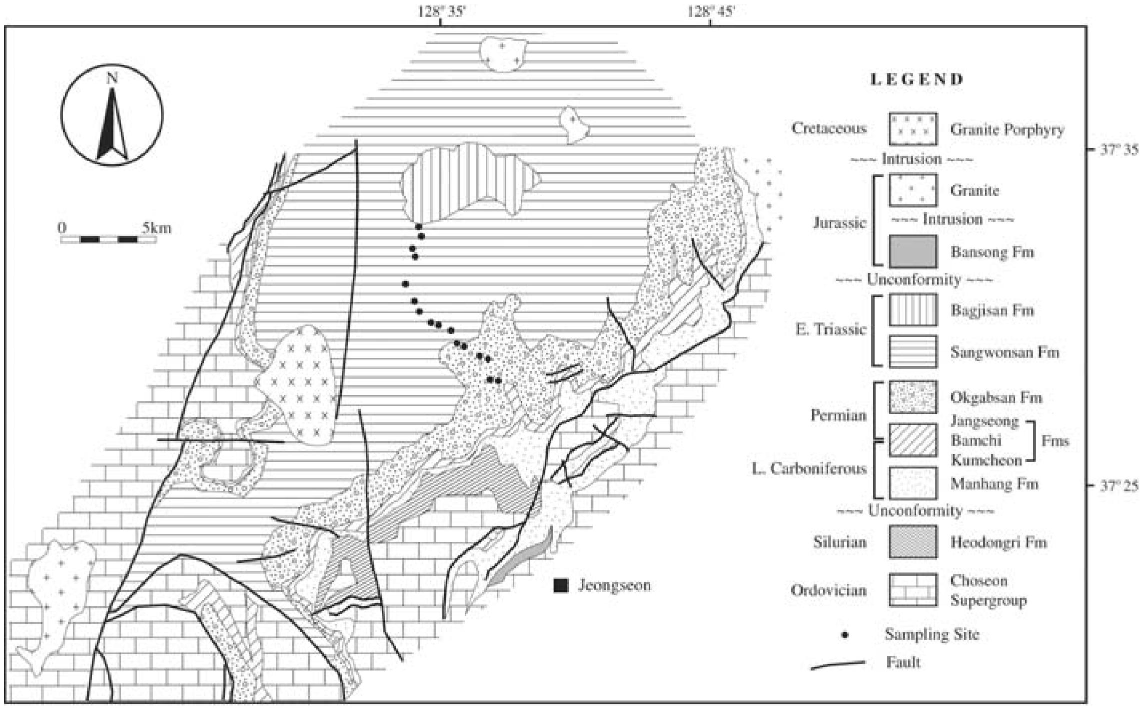

Figure 1. Geological map of the Jeongseon area. Also shown are Park *et al.*'s (2003) sampling sites (solid dots). From Korea Inst. Geol. and Min. Res. (1975), and Kim *et al.* (2001).

1992; Lee *et al.* 1992; Kim & Kim 1996; Oh & Lee 2000; Choi 2002; Choi *et al.* 2003). These intrusions are likely to remagnetize the surrounding rocks. In fact, there is a Late Cretaceous pluton in the study area of Park *et al.* (2003) although they did not present the pluton in their fig. 1. Fig. 1 shows the geological map of Park *et al.* (2003) after adding the Mesozoic plutons, as shown in the recent geological map of Kim *et al.* (2001). The Rb–Sr whole rock age of the Cretaceous plutons in the Pyeonchang-Jeongseon area, adjacent to Park *et al.*'s (2003) sampling sites, gives a crystallization age of 92.4 ± 1.6 Ma (Choo & Chi 1989). This Late Cretaceous age of pluton emplacement coincides with Park *et al.*'s (2003) inferred remagnetization age. Thus, it is reasonable to conclude that the remagnetization was caused by thermal effects of the pluton and/or associated 'short-distance' hydrothermal fluids, rather than fluid travelling more than 800 km along fault zones from a selective generation site on the subducting slab as shown in fig. 13 of Park *et al.* (2003).

(2) Park *et al.* (2003) cited Sillitoe (1977) and Kong *et al.* (1997) in stating that 'basinal fluid events were triggered by the Kula-Eurasia convergence and migrated through the fault system within the Ogcheon Fold belt during the Cretaceous period.' However, Kong *et al.* (1997) presented a model for the evolution of the East China Sea based mainly on seismic stratigraphic sections, without mentioning anything about fluid migration along the fault system of the Okcheon belt. Furthermore, Sillitoe (1977) likewise made no mention of fluid migration along the fault system of the Okcheon belt. Sillitoe (1977) proposed that ore deposits in the Gyeongsang basin of southeast Korea were generated by the Late Cretaceous calc-alkaline magmatism associated with a northward subduction of the Kula plate.

(3) Park *et al.* (2003) cited Ree *et al.* (2001) in stating that there are many thrusts in the more intensively deformed northwestern region (Jeongseon area), while there are a limited number of thrusts in the southeastern region (Taebaek area). However, there is neither such statement nor implication in Ree *et al.* (2001). In fact, regional-scale NNE-striking strike-slip faults and NE- to E-striking thrusts are widespread also in the Taebaek area (e.g. Kim & Choi 1990; Kim & Kim 1991; Lee *et al.* 1994). In particular, when comparing the geology of Park *et al.*'s (2003) study area (Fig. 1) with that of the Taebaek area (fig. 2 of Kim & Choi 1990), it is apparent that the fault population is rather larger in the southeastern region or Taebaek area.

In summary, for an interpretation of palaeomagnetic data to be enlightening, geological factors need to be taken into rigorous consideration. Park *et al.*'s (2003) main conclusion that long-distance fluid migration is responsible for the remagnetization seems to be a misinterpretation.

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