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Decratonic gold deposits: a new concept and new opportunities

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Early Cretaceous gold deposits in the North China Craton and the famous Carlin-type gold deposits in Nevada are given the name 'decratonic gold deposits' [1]. This is the first new type of ore deposit proposed in the last 20 years. This new type of deposit introduces a concept that may change perspectives and provide fresh opportunities for gold deposit research and exploration.

Cratons are stable ancient crustal domains characterized by thick lithospheric mantle roots (>150 km), weak tectonism, and little or no magmatic activity within their boundaries. Since their stabilization, the formation of endogenic mineral deposits in such ancient cratonic blocks is very rare owing to a lack of significant magmatism, deformation, or generation of hydrothermal fluids.

Several cratons, however, including the North China, the North American and the Brazilian cratons, have experienced destruction to differing degrees [1]. The eastern part of the North China Craton was extensively destructed in the Early Cretaceous [2]. Meanwhile, gold deposits with a total reserve of 4000–5000 tons formed there within a few million years (130–120 Ma), coeval with craton destruction [1]. Similarly, the western part of the North American Craton was destabilized in the Cenozoic and that destruction may be responsible for the famous Nevada Carlin-type gold deposits that host a total of over 6000 tons of gold reserves [1,3]. It is suggested that all these deposits now be termed 'decratonic type' gold deposits, deposits formed by magma-derived fluids under extensional tectonics conditions associated with craton destruction [1]. The model further postulates that the westward subduction of the western Pacific Plate in the Early Cretaceous and the eastward subduction the eastern Pacific Plate in the Cenozoic were responsible for these two major gold mineralization events. Dehydration of the subducted and stagnant slabs led to continuous hydration and metasomatism of the overlying mantle wedges and the enrichment of gold and other chalcophile elements. Subsequent partial melting of the mantle wedge produced ore-forming fluids (Fig. 1) [1].

Gold deposits in the North China Craton have been classified into two types: 'altered-rock' type and 'quartz-vein' type. The altered-rock-type gold deposits are characterized by disseminated and stockwork gold mineralization, which is usually controlled by brittle or ductile to brittle fault zones. These types of deposits have commonly been intensively overprinted by hydrothermal alteration and suffered later brittle deformation. The quartz-vein-type gold deposits are hosted in the Archean amphibolite facies rocks or earlier granitoids and typically have large proportions of visible native gold. In contrast, the Carlin-type gold deposits in Nevada typically contain invisible gold hosted in fine-grained sulfides disseminated in Paleozoic marine sedimentary rocks. The North China Craton and Carlin gold deposits are seemingly entirely different, but both types are genetically related to craton destruction. Carlin-type gold deposits are abundant in Nevada but have not been found in the North China Craton. The decratonic gold deposit model ascribes the contrast in mineralization styles to host rocks, controlling structures, and ore-forming depths [1].

Decratonic gold deposits in both the North China Craton and Nevada formed within a relatively short time interval (<10 Ma). In both areas, the deposits become progressively younger toward the subduction zones. Such temporal trends may plausibly be explained by subduction retreat or rollback of the subducted slab at rates of 8.8 and 3.3 cm y^{-1} for the western and eastern Pacific plates, respectively [1].

Craton destruction starts deep in the mantle with mantle-derived melts and fluids, implying that decratonic gold deposits may extend to great depths. This suggests new opportunities for future discoveries. It is proposed that gold mineralization belts extending approximately NNE in the eastern and the western portions of the Eastern Block of the North China Craton are the most favorable areas for future exploration [1].

'Decratonic gold deposit' is a new term. It will inevitably face reactions that will affirm or challenge it, and that may improve or refute it. Major questions are: the (paleo)-Pacific plate has subducted westward underneath the whole of east China followed by slab rollback during three periods since the Jurassic [4,5]. Why did gold mineralization in the North China Craton take place mainly within a short period in the Early Cretaceous? Episodes of tectonic extensions in the North China Craton also have lasted for long periods. What made the Early Cretaceous so different? If craton destruction was the controlling factor, then what made craton destruction unique? Alternatively, are craton

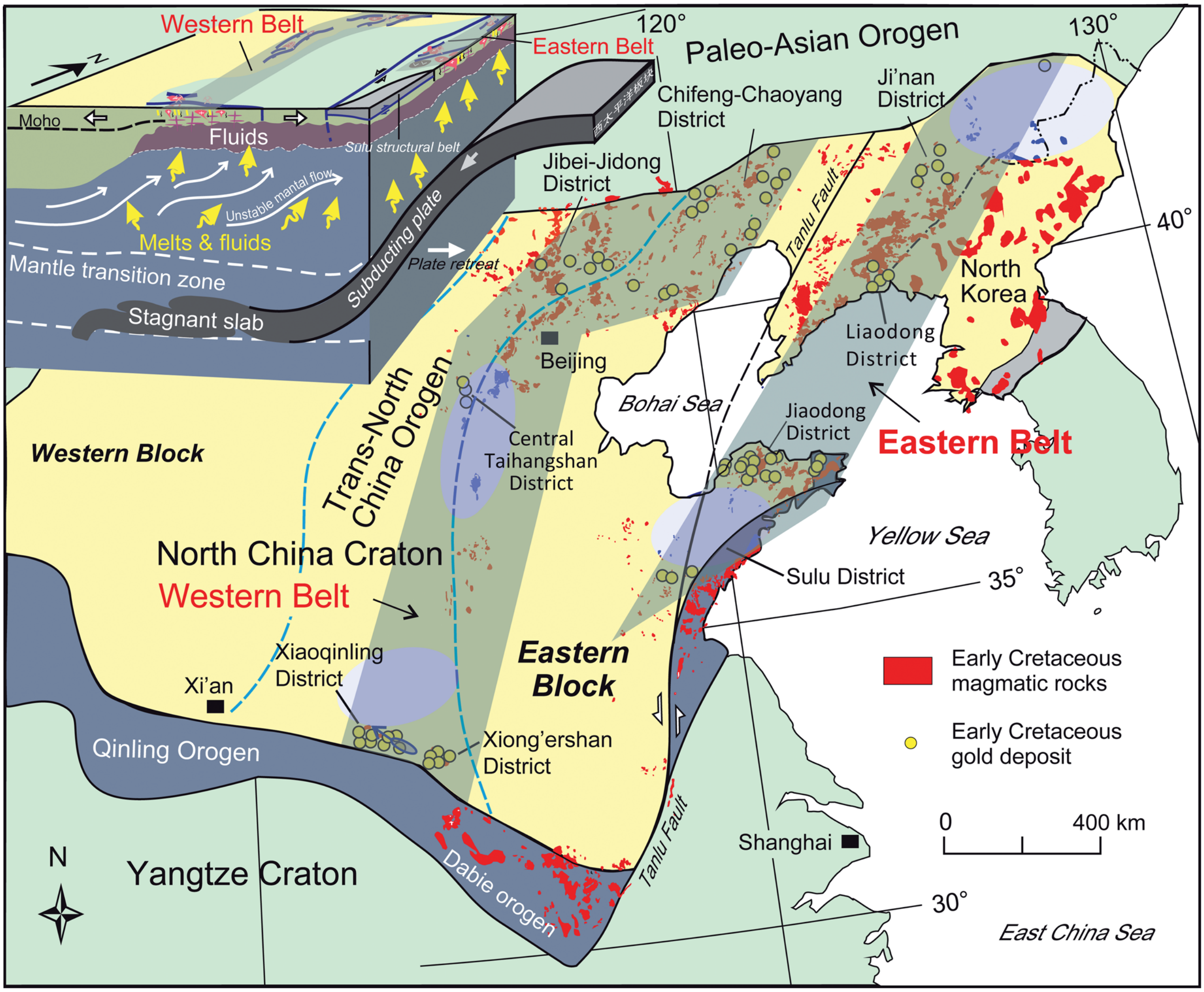

Figure 1. Distribution of Early Cretaceous gold deposits in the North China Craton. The sketch shows the essentials of gold deposit formation according to the decratonic gold deposits model and also indicates promising prospection regions. Modified after [1]. Gray shaded bands mark the two known gold belts; purple circles mark promising targets for future gold exploration.

destruction and slab rollback both required for decratonic gold deposit development? If so, why? The whole North China Craton experienced destruction, but why are gold deposits concentrated in two distinct gold belts? Is mineralization controlled by paleo-convergent margins [5]? Did brief compression/transpression between major extensions play a role, as proposed by Sun and others [4,5]? These questions await answers but also provide new opportunities for geologists. It seems inevitable that the major mantle upwelling induced by craton destruction should have led to large-scale metamorphism within the overriding crust. This would release metamorphic fluids that could play a role in the large-scale gold mineralization events.

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REFERENCES

1. Zhu, RX, Fan, HR and Li, JW *et al. Sci China-Earth Sci* 2015;**58**: 1523–37.
2. Zhu, RX, Chen, L and Wu, FY *et al. Sci China-Earth Sci* 2011;**54**: 789–97.
3. Muntean, JL, Cline, JS and Simon, AC *et al. Nat Geosci* 2011;**4**: 122–7.
4. Sun, WD, Ding, X and Hu, YH *et al. Earth Planet Sci Lett* 2007;**262**: 533–42.
5. Sun, WD, Li, S and Yang, XY *et al. Int Geol Rev* 2013;**55**: 311–21.

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