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Comment on "Re–Os pyrite and U–Pb zircon geochronology from the Taldybulak Levoberezhny gold deposit: Insight for Cambrian metallogeny of the Kyrgyz northern Tien Shan" by Xiaobo Zhao, Chunji Xue, Guoxiang Chi, Nikolay Pak, Bo Zu [Geol. Rev. 67 (2015) 78–89]

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1. Introduction

In their recent article, Zhao et al. (2015) presented new geochronological data on the age of gold mineralization at the Taldybulak Levoberezhny gold deposit in Kyrgyzstan: "The Re–Os dating of gold-bearing pyrite from the early stage mineralization yielded an isochron age of 511 ± 18 Ma, while a diorite dike post-dating the late stage quartz–tourmaline–gold formation yielded a zircon SHRIMP U–Pb age of 414.6 ± 6.8 Ma, the latter representing the youngest limit of gold mineralization". Discovery of Cambrian gold mineralization at the Taldybulak Levoberezhny deposit is of great importance for understanding of a multi-stage geological evolution of the deposit. However, conclusions regarding the youngest age limit of gold mineralization are quite controversial. In connection with this I would like to address the following issue:

What are the meanings of zircon U–Pb ages derived from diorite?

Zhao et al. (2015) used the Re-Os dating of gold-bearing pyrite (511 ± 18 Ma) from the early stage mineralization. From the methodological point of view, it is strange that the same method was not used for dating pyrite from the later and main stage gold mineralization. Instead the youngest age limit of gold mineralization was constrained with a zircon SHRIMP U–Pb age of a diorite dyke (414.6 ± 6.8 Ma), which was presented as a post-ore unit. However, the latter statement contradicts to the geological data collected during years of research.

1.1. Geological background

According to geological data collected during detailed evaluation of the deposit in 1983–1987, and on the basis of the K-Ar dating (Table 1) Trifonov et al. (1987a,b), Trifonov (1987) proposed the following sequence of geological events at the Taldybulak Levoberezhny gold deposit:

1) Proterozoic – formation of mélange zone in the metamorphic basement with transformation of basic-ultra-basic igneous rocks due to magnesium-quartz-carbonate alteration;
2) Devonian – intrusion of diorite subvolcanic rocks followed by carbonatization and sericitization of host rocks and formation of beresites and listvenites;
3) Devonian to Carboniferous – formation of polymetallic mineralization;
4) Carboniferous – intrusion of diorite-monzonite subvolcanic rocks followed by tourmalinization of host rocks;
5) Late Paleozoic to early Mesozoic(?) – main gold mineralization event;
6) Paleogene(?) – intrusion of post-mineral dolerite-trachydolerite dykes.

According to this scenario, mineralization at the deposit is a multi-staged with several generations of pyrite, which is the most

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Table 1
K-Ar ages of rocks and alteration from the Taldybulak Levoberezhny gold deposit, analyzed in the Institute of geochemistry and physics of minerals (IGFM), Academy of sciences of Ukraine, Kiev, 1983. (Trifonov et al., 1987a,b.)

Sample	Rock	Potassium, %	Argon, ng/t	Age, Ma
05-6	Sericitized migmatite	0.75	22.3	384
306-9	Quartz-sericite metasomatite	3.33	87.6	345
ФПИ-2	Fuchsite from listvenite	3.99	125.2	403
05–3	Diorite from explosive breccia	3.24	94.3	377
100504	Diorite-monzonite porphyry	3.91	94.8	320
100508	Albitized migmatite	5.1	112.5	290
100613	Albitite from shear zone	3.06	41.0	183
94.3	Trachydolerite (post-mineral)	0.825	Air*	

* The concentration of argon in the sample is very low, implying a very young age (Paleogene?) of the rock.

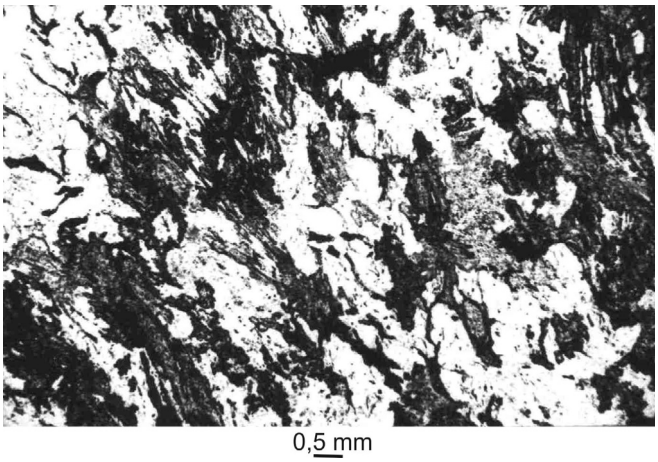

Fig. 1. Microphotograph in transmitting unpolarized light, showing the replacement of diorite-monzonite porphyry (light background) by quartz-tourmaline aggregate (dark). (Trifonov et al., 1987b.)

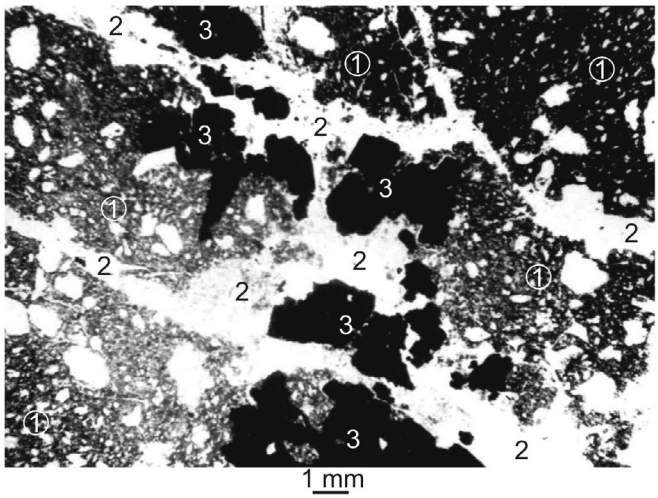

Fig. 2. Microphotograph in transmitting unpolarized light, showing relationships between quartz-tourmaline aleration (1) with quartz-carbonate (2)–pyrite (3) veinlets of the main stage of gold mineralization. (Trifonov et al., 1987b.)

common sulfide mineral. However, productive gold mineralization is genetically and structurally related to a volcano-plutonic (porphyry) formation developed during the Devonian to Carboniferous tectono-magmatic activation. Fluidization of apical parts of a diorite-monzodiorite subvolcanic swarm was followed by extensive tourmalinization. Quartz-tourmaline alteration with a low grade gold mineralization (0.0n–1 g/t Au) was superimposed on diorite-monzonite (Fig. 1). Products of the main stage gold mineralization (0.n–10n g/t Au, with an average grade of 6.9 g/t Au) represented by quartz-carbonate-sulphide (pyrite-chalcopyrite) stringer-disseminated mineralization were superimposed on the earlier listvenite-beresite and later quartz-tourmaline alteration (Fig. 2).

Some reports on the geology of the Taldybulak Levoberezhny gold deposit (Malyukova, 2001; Seltmann and Porter, 2005; Seltmann et al., 2014; Djenchuraeva et al., 2008) presented practically the same sequence of geological events. Common to all schemes is the correlation of main gold mineralization to post-magmatic hydrothermal processes of the diorite-monzonite (porphyry) system. Moreover, all workers showed that quartz-tourmaline alteration was superimposed on diorite-monzodiorite porphyritic rocks, and main gold mineralization was superimposed on quartz-tourmaline alteration. Relationships between the geological formations are well illustrated in the deposit model published by Djenchuraeva et al. (2008), (Fig. 3).

1.2. Interpretation of the meanings of SHRIMP U-Pb zircon ages of a diorite dike

Zhao et al. (2015) divided zircons from a diorite dike into three groups by crystallographic forms and age: group A (weighted mean 206Pb/238U ages of 796.8 ± 9.6 Ma; N = 7, MSWD = 2.1); group B (weighted mean 206Pb/238U ages of 414.6 ± 6.8 Ma; N = 5, MSWD = 2.3) and group C (two grains of 312.5 and 290.7 Ma). The authors suggested that zircons of group A were inherited from the Precambrian basement of the Aktyuz terraine; zircons of group B corresponded to the age of the diorite dike; and zircons of group C reflected a reset or hydrothermal alteration after emplacement of the dike. The youngest age limit of gold mineralization was attributed to the age of the diorite dike (414.6 ± 6.8 Ma) by reference that the dike belongs to the post-ore magmatism. But this conclusion contradicts the geological data presented above. Unfortunately, the authors interpreted diorites as products of post-ore magmatism without any additional evidence, and used incorrectly the previous geological models by simple substitution of relationships between diorites with quartz-tourmaline alteration and ore bodies (compare Figs. 4 and 5). Moreover, such substitution was not done very accurately. As a result the new model bears conflicting fragments of different options for the relationships between geological units. In some cases, diorites intrude quartz-tourmaline alteration and ore bodies, and in the others is the opposite relationship (Fig. 5).

The inconsistencies in representation of geological data cast doubt on the general interpretation of the U-Pb zircon age dating. According to the previous geological data, it is most likely that diorite-monzodiorite preceded quartz-tourmaline alteration and the latter preceded the main stage of gold mineralization (quart z-carbonate-pyrite-chalcopyrite). In this model, the age of the main stage gold mineralization could be correlated with the age

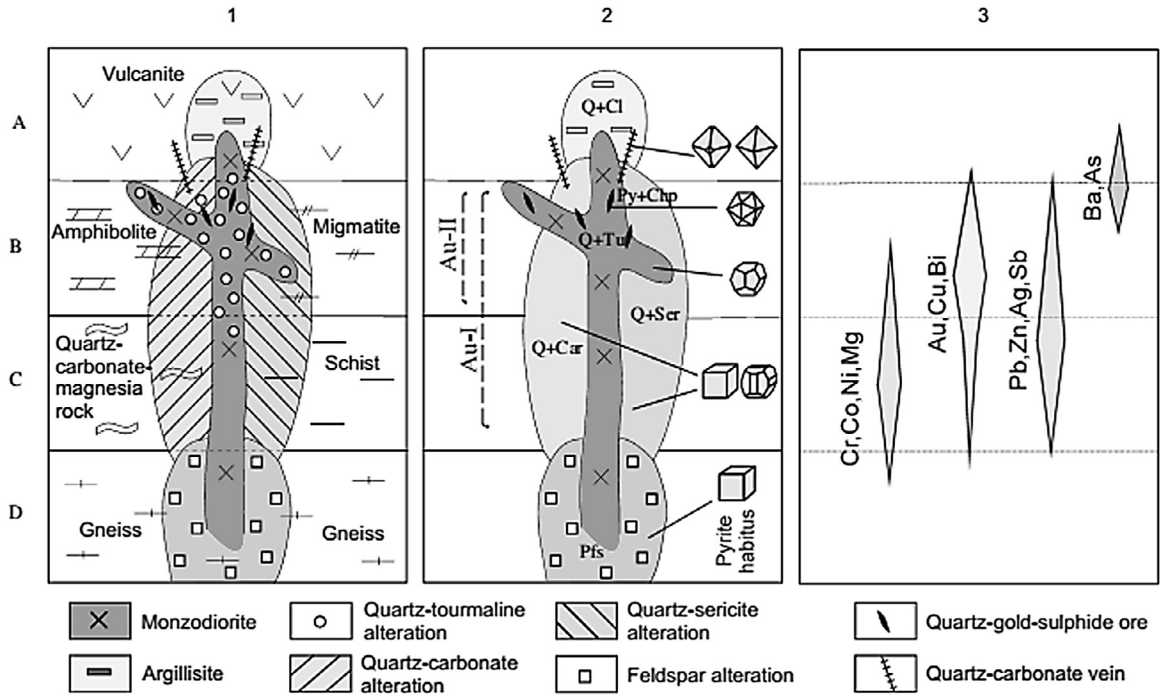

Fig. 3. A model of alteration (1), mineral (2) and geochemical (3) zoning at the Taldybulak Levoberezhny gold deposit (Djenchuraeva et al., 2008). Alteration: A, frontal; B, prefrontal; C, intermediate; D, inner. Minerals: Q, quartz; Car, carbonate; Ser, sericite; Tu, tourmaline; Pfs, K-feldspar; Cl, clay minerals; Py, pyrite; Chp, chalcopyrite.

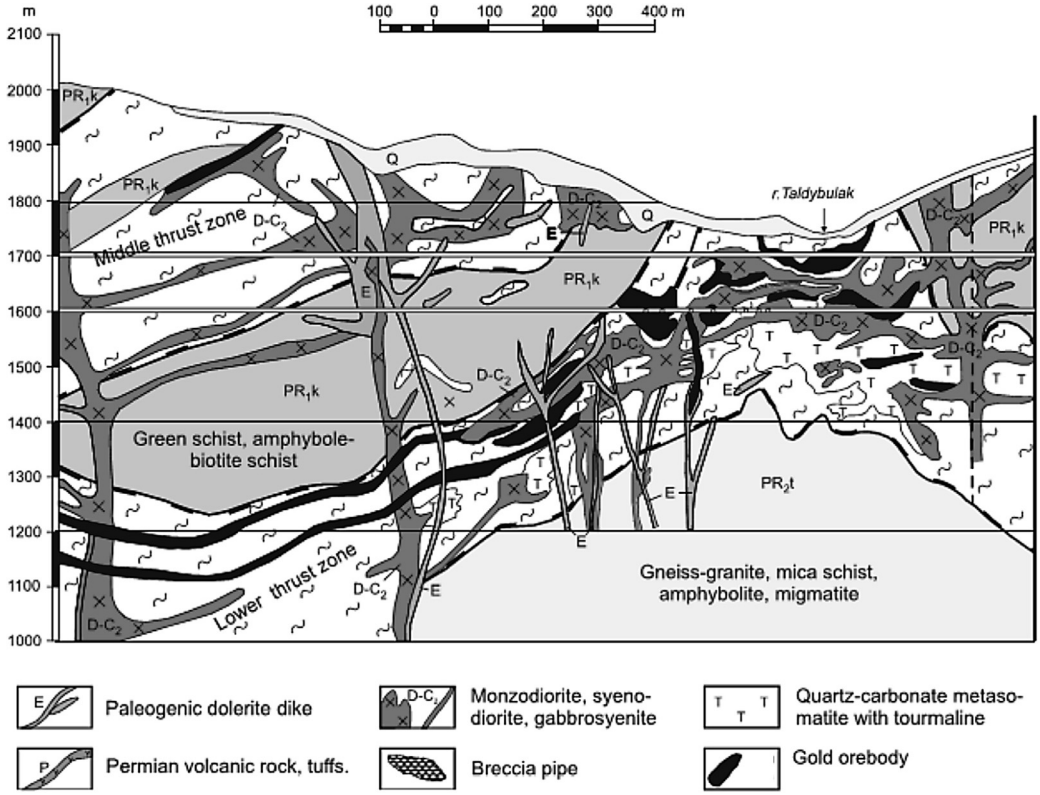

Fig. 4. Simplified geological cross-section of the Taldybulak Levoberezhny gold deposit. (Djenchuraeva et al., 2008). The figure shows that gold ore bodies are superimposed on monzodiorites and quartz-tourmaline alteration.

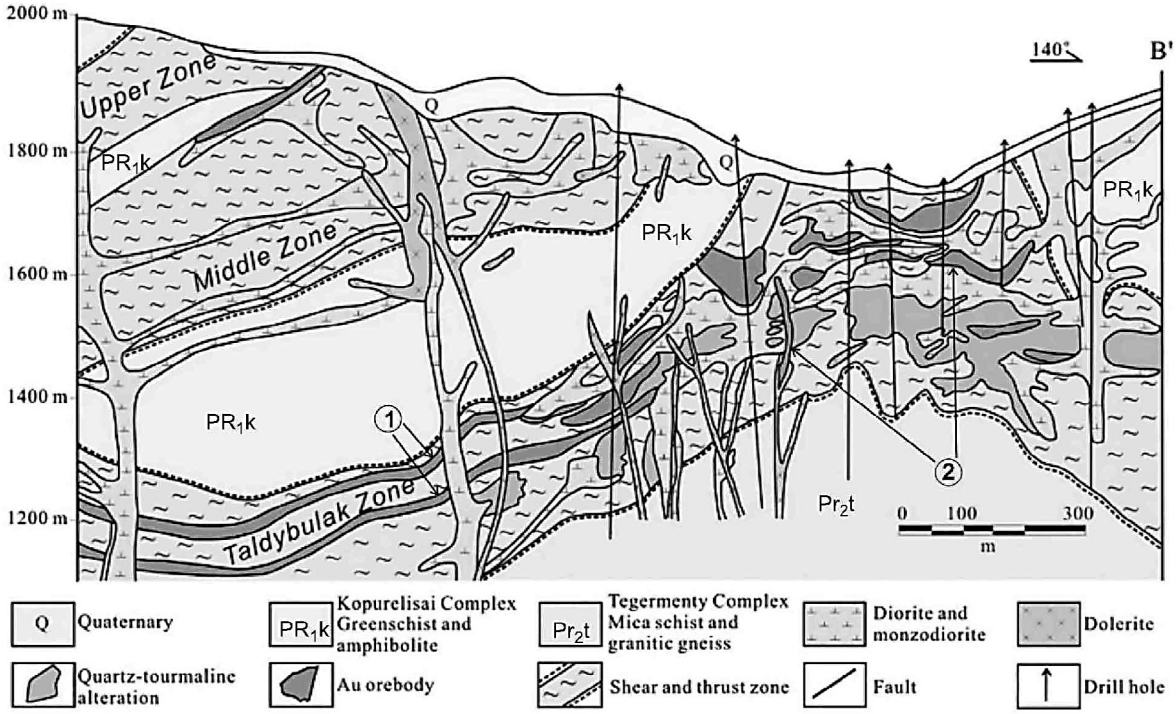

Fig. 5. Simplified geological cross-section of the Taldybulak Levoberezhny gold deposit. (Zhao et al., 2015). This figure is almost identical to Fig. 4. However, there is contradiction. Encircled numbers with arrows indicate areas with conflicting relationships of geological units: 1 – diorite-monzodiorite is superimposed on ore bodies; 2 – ore bodies are superimposed on diorite-monzodiorite.

of zircons of group C (312.5 and 290.7 Ma), which is in good agreement with the previously presented models of the deposit (Trifonov et al., 1987a,b; Malyukova, 2001; Seltmann & Porter, 2005; Seltmann et al., 2014; Djenchuraeva et al., 2008).

2. Conclusions

The Re–Os age dating of gold-bearing pyrite from the early stage mineralization (511 ± 18 Ma) at the Taldybulak Levoberezhny gold deposit is important. These new data support an idea of the multi-stage mineralization at this deposit. They convince one of the main conclusions of the authors that "The newly recognized Cambrian mineralization event calls for re-evaluation of the gold metallogeny in the eastern Northern Tien Shan". However, interpretation of the U-Pb zircon age of diorites is ambiguous and contradictory. More research is needed to work with controversial issues of the age of the Taldybulak Levoberezhny gold deposit. It would be desirable to supplement the Re–Os age dating of pyrite from the early stage gold mineralization (Zhao et al., 2015) with the same Re–Os age dating of pyrite from the late and main stage of gold mineralization.

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References

Djenchuraeva, R.D., Borisov, F.I., Pak, N.T., Malyukova, N.N., 2008. Metallogeny and geodynamics of the Aktiuz-Boordu Mining District, Northern Tien Shan, Kyrgyzstan. J. Asian Earth Sci. 32, 280–299.

Malyukova, N., 2001. The Taldybulak Levoberezhny gold deposit, Paleozoic geodynamics and gold deposits in the Kyrgyz Tien Shan. In: Seltmann, R., Jenchuraeva, R. (Eds.), Excursion Guidebook. Series 9 and Annual Newsletter of IGCP-373, pp. 97–109.

Seltmann, R., Porter, T.M., Pirajno, F., 2014. Geodynamics and metallogeny of the central Eurasian porphyry and related epithermal mineral systems: a review. J. Asian Earth Sci. 79, 810–841.

Seltmann, R., Porter, T.M., 2005. The porphyry Cu-Au/Mo deposits of Central Eurasia: 1. Tectonic, geologic and metallogenic setting and significant deposits. In: Porter, T.M. (Ed.), Super Porphyry Copper and Gold Deposits, A Global Perspective, vol. 2. PGC Publishing, Adelaide, pp. 467–512.

Trifonov, B.A., 1987. Ore-controlling reverse-thrusting zones in Kyrgyzstan. In: The First All-Union Sci. Conference: Metallogeny of the Tien Shan. Frunze, pp. 174–176 (in Russian).

Trifonov, B.A., Koleda, A.J., Koloskov, V.P., 1987a. The manifestation of a new gold-porphyry type mineralization in Kyrgyzstan. The First All-Union Sci. Conference: Metallogeny of the Tien Shan. Frunze, pp. 203–205 (in Russian).

Trifonov, B.A., Koleda, A.J., Komissarov, V.A., Funt, B.B., 1987b. Patterns of Distribution of Gold Mineralization at the Taldybulak Levoberezhny Gold Deposit. Polytechnic Institute, Department of Geology of Kyrgyzstan, Frunze. 262 p. (in Russian, Scientific-production report).

Zhao, X., Xue, C., Chi, G., Pak, N., Zu, B., 2015. Re-Os pyrite and U-Pb zircon geochronology from The Taldybulak Levoberezhny gold deposit: Insight for Cambrian metallogeny of the Kyrgyz northern Tien Shan. Ore Geol. Rev. 67, 78–89.