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Sediment-hosted gold deposits; in a class on their own, with examples from Central Asia

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Sediment-hosted gold deposits have been variously categorized as orogenic gold deposits, turbidite-hosted gold deposits or Carlin-type gold deposits. They are stratabound and discordant to bedding, comprised of disseminated pyrite (+/-arsenopyrite and pyrrhotite) and concentrated in black shale, siltstone, carbonate and sandstone sequences. Some of the world's largest gold districts/deposits are of this type and many occur in Asia, includingMuruntau, Kumtor, Sukhoi Log, Western Qinling Belt and Dian-Qian-Gui district. Quartz veining may or may not be present. Gold may be refractory (dissolved within arsenian-pyrite or arsenopyrite), or, in the case of many deposits, occurs as free gold or gold tellurides, within metamorphic and/or hydrothermal pyrite, arsenopyrite or associated quartz veins. The key criteria for considering this diverse group of deposits together is that they are hosted by sedimentary rocks, and in particular, carbonaceous mudstones or shales make up a significant component of the sedimentary succession.

Recent advances in LA-ICPMS analysis on the micron scale has enabled a new approach to resolving the genesis of these deposits, by employing laser mapping techniques combined with Pb-isotopes to determine the chemical evolution of sulfides and the relative timing of gold input into the deposits. This research clearly shows that for many of these deposits (e.g. Kumptor and Sukhoi Log) gold, As and Te were absorbed into early sedimentary and diagenetic pyrite in black shales during sedimentation. During deformation, or granite intrusion, and metamorphism in deeper parts of the black shale basins, at middle greenschist facies, pyrite was converted to pyrrhotite and Au, As, Te and S were released to the metamorphic fluid and travelled up stratigraphy to be deposited in structural traps, particularly anticlinal positions, towards the top of the black shale sequence. At the stratigraphic level of the ore deposits, above the pyrrhotite metamorphic zone, pyrite in the ores demonstrate several stages of growth starting with the earliest sedimentary pyrite, overgrown by diagenetic pyrite, and overgrown again by one or two generations of hydrothermal pyrite. The LA-ICPMS mapping enables the chemical pargenesis of the complex pyrite aggregates to be mapped-out and the precise time of gold events to be determined.

Our studies show that Kumptor is an excellent example of the concentration of Te and Au in the early syn-sedimentary pyrite of the black shale host rocks, followed by release during metamorphism, and concentration in hydrothermal pyrite as micro-grains of Pb-Bi-Ag-Au-tellurides.