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# Gold Deposits of the CIS

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painstaking elucidation of the characteristics of, and relationships between, organisms. This work is unglamorous; sometimes, as Fortey remarks, it is dismissed as "counting hairs on legs". Yet it is fundamental to all biosciences, including palaeontology. New species are being discovered all the time and we only know they are new by consulting the archive of known and described species. As Fortey points out, in some groups, such as beetles and fungi, millions of species remain to be described and named. Further, Fortey notes the urgency of this task; documenting the world's biodiversity is critical in the light of increasing extinction rates. Although the whole organism is still the fundamental unit of study, especially for elucidating structures and behaviour, Fortey acknowledges the undoubted advances in molecular studies in recent years, and their value in unravelling knotty taxonomic conundrums. He illustrates this with a compelling but complicated example from truffle taxonomy. Cladistics is discussed too. Lest one should think of taxonomy as sterile and irrelevant, Fortey presents examples of its practical implications, including research towards the eradication of diseases such as bilharzia, the control of harmful insect pests, and development of more productive agricultural crops. The impacts of this work can be far-reaching.

Museums have not been immune to the upheavals and dislocations consequent upon social and economic changes in recent years. Fortey documents their impact on the NHM, especially the imposition of a business model of operation, and the resulting reorganization and staff cuts. This model often requires justification of research in terms of immediate benefits, which militates against the "research for its own sake" ethos. Fortey is clearly at odds with the new system; he presents several examples of unanticipated benefits resulting from curatorial work that was driven solely by scientific curiosity. Perhaps the most surprising is the discovery of a lost Mozart manuscript by a researcher looking for illustrations of herring. Fortey also describes the tensions between the front of house (exhibitions and public areas) and back of house areas (collections and research labs) and the increasing staff numbers being allocated to marketing and fund raising, rather than curatorial work and research. Galleries, exhibitions, and outreach get limited discussion, although Fortey recognizes changing public expectations for museums through the years. He touches only briefly on his experience in gallery development. Evidently, there is another book to be written about this aspect of museum work, in which curators are often heavily involved. However, here the focus is firmly on the back of house activities. Fortey notes, with perhaps a certain amount of regret, the increasing lack of tolerance for eccentricity or, with less regret, for non-productivity. He also describes every curator's worst nightmare: rogues in the museum, or people who gain positions of trust and then steal specimens. Thankfully, Fortey concentrates more on the positive and contributory aspects of the passion for collections.

I found myself cheering, chuckling and smiling wryly at many places in this book. It is hugely entertaining. True, it could be classified as a gentle polemic or as self-justification. Special pleading? Well, perhaps. Some of the situations Fortey describes are particular to museums. Yet his "tell it like it is" account of museum life includes much that will be familiar to anyone who has ever worked in a similar large institution or organization, such as a university or geological survey. His discussion is wide-ranging, persuasive, thought provoking, and lucid. As a curator myself, I certainly agree with Fortey that museums are special places. Now, thanks to Fortey's splendid portrayal, the pleasures and implications of museum work can be widely shared. I highly recommend his book to my colleagues in geoscience.

## Gold Deposits of the CIS

**Gregory Levitan**
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*Gold Deposits of the CI*S (i.e. Commonwealth of Independent States) provides a series of brief descriptions of the major gold deposits and resources of the former Soviet Union (FSU). This region of Eurasia, extending from latitude 30°E (Ukraine) to 175°E (Kamchatka), and as far south as latitude 39°N (Tajikistan), is defined as containing the world's largest cumulative gold reserve. Although a few major deposits such as Muruntau, Kumtor, and Sukhoi Log have recently received attention in the Western economic geology literature, many of the large gold systems in this region lack any English-language geological description beyond a few vague sentences on company websites. Thus, this book attempts to fill a need in the basic ore geology literature.

The author of the volume, Gregory Levitan, is among the few individuals qualified to fill such a need in the economic geology field. He worked on mineral deposits for the Soviet Ministry of Geology for 35 years within the FSU, before moving to the West and spending the most recent fifteen years as a consultant specializing on gold ores within the same vast region. His most recent experience is reflected in the inclusion of available mining and mineral economics data on described deposits, material commonly lacking in other published descriptions of gold deposits within the FSU.

The book begins with two brief introductory chapters, one on the history of exploration and mining, and the second describing the complex classification system of gold deposits in the CIS. The classification system is

based on gold ore host rocks and is used to subdivide the remainder of the book. Deposits are grouped into those associated with Archean and Paleoproterozoic host rocks (Chapter 3), and Neoproterozoic through Phanerozoic sedimentary, intrusive, and volcanic host rocks (Chapter 4). Most western readers will recognize orogenic, intrusion-related, skarn, and Carlin-type deposits as being described within the first three groups of host rocks, and the epithermal deposit types as being discussed within the volcanic rock-related section of the book. These four groups of gold deposits are further subdivided into sections within chapters 3 and 4; these sections are based on both, mineralization style and major mineralogical signatures of the ores. The deposits discussed in this book are strictly those in which gold, or rarely silver, is the dominant ore component. Hence, large auriferous porphyry copper deposits, such as the giant Almalyk system in Uzbekistan, are not described.

Chapters 3 and 4 are three- to five-page-long descriptions of 51 major gold deposits that occur in the FSU. Each description typically includes location coordinates, regional and local geological descriptions, maps and cross-sections of variable quality, ore and alteration mineralogy, available grade and tonnage data, any published geochronology, summary of interesting geochemical features, and the dominant genetic interpretation(s) on ore formation. Chapter 3 summarizes the older FSU gold deposits; these Precambrian ores are basically the orogenic gold deposits of the Ukrainian Shield in the southwestern corner of the East European Platform.

Chapter 4 discusses the remaning gold deposits and thus constitutes the bulk of the book. The sedimentary rock-hosted deposits are divided into those hosted by a) metamorphic sequences, b) black shales and carbonates, and c) sedimentary and carbonate rocks. The first of these groups is characterized by limited arsenic concentrations in pyrite, relatively high formation pressures and temperatures, 'greenstone' (probably meaning greenschist) facies metamorphism, and thick flysch over mature continental crust, which would suggest a back-arc tectonic setting. These ores in metamorphic sequences are further broken down into 'deposit types' that include gold–feldspar–carbonate–quartz (Kumtor), gold–quartz (Sovetskoye), gold–feldspar–carbonate-sulfide (Muruntau), and gold–quartz ± carbonate (Sukhoi Log). At times, the numerous levels of classifications seem to become too complex and can be contradictory and confusing. For example, in the section describing the gold–feldspar–carbonate–quartz type deposits, a discussion of Muruntau follows that of Kumtor and begins by stating Muruntau is *another* example of gold–feldspar–carbonate-sulfide type mineralization. What happened to the 'quartz'? Furthermore, the Muruntau mineralization is said to reflect two stages of hydrothermal activity, and to contain five assemblages that are not related to these stages, although the fifth assemblage is actually called a 'stage'. The second sedimentary rock-hosted group (black shales and carbonates) includes deposits such as Olimpiada, Bakirchok, and Daugyztau. Many features of this group are not obviously different than the features of the first group; for example, host rocks are affected by greenschist metamorphism, gold-bearing arsenopyrite is present, and formation temperatures above 400 °C are reported for some of the largest deposits. Yet some deposits in this group are lower temperature and seem to resemble epizonal Sb-rich orogenic gold deposits, such as the Alaskan Donlin Creek deposit. Also, gold–mercury–quartz deposits in this group have similarities with Carlin ores; these include Kyuchus in eastern Russia and perhaps Vorontsovka in the Urals. If I had to generalize, my opinion would be that this second group includes some of the same mesozonal orogenic gold deposits that are grouped within metamorphic sequence host rocks, as well as epizonal orogenic and Carlin-type gold deposits. The third group (sedimentary and carbonate rocks) is suggested to consist of epithermal gold deposits in lower greenschist facies rocks and distal to any known igneous rocks. The silver-rich nature of these deposits (e.g. Okzhetpes) and reported low-temperature phases such as kaolinite and dickite, are used to support such an interpretation.

The intrusion-related gold deposits described in Chapter 4 are also divided into three subgroups: a) stockworks, veinlets, and disseminations in plutons (e.g. Vasil'kovskoye, Jilau); b) veins within and near plutons (e.g. Jerooy, Natalka, Darasun, Kochkar, Berizovsk); and c) skarns (e.g. Makmal). Levitan states that all the deposits are defined by a close spatial or genetic link to plutons, although it seems that there is also a spatial link between intrusions and many of the sedimentary-rock hosted deposits. The first two subgroups are defined as 'porphyry gold deposits' and are stated to differ from the classic intrusion-related gold system at Fort Knox, Alaska, by the greater abundance of sulfide minerals and the more mafic character of igneous phases. The vein-type subgroup is further subdivided into gold–quartz and gold-sulfide–quartz deposits based on sulfide volumes of less than or greater than five percent, respectively. Although some of these may indeed be 'intrusion-related', descriptions of other deposits, such as Jilau, where ore occurs in the sheared margins of plutons, may indicate similarities to the sedimentary rock-hosted deposits. The gold deposits that are related to volcanic rocks are classified as gold-telluride (e.g. Zod, Kochbulak), gold related to andesite–dacite (e.g. Kubaka, Baley), and gold–silver or silver related to dacite–rhyolite (e.g. Dukat). These are generally equivalent to alkalic-related, high sulfidation, and low sulfidation epithermal precious-metal systems, respectively.

The descriptions of the deposits summarize the information available from all published sources in the Russian literature and from Levitan's site visits. It would have been helpful if the author had been a little more critical in evaluating the often quite variable information. For example, in discussing Muruntau, one paragraph states that the ores formed in two stages at 245 and 220 Ma, and thus long after magmatism, whereas the next paragraph reports a 287 Ma date for mineralization that is coeval with magmatism. Which paragraph should the readers believe? Broad ranges of fluid inclusion temperatures are reported for many deposits, such as

465 to 100°C at the Kochbulak epithermal deposit, but what does such a range tell us about temperatures of ore formation? A meteoric water origin is stated for the Maiskoye gold deposit based on hydrogen and oxygen isotope compositions of bulk extractions of fluid inclusion waters, but is such an interpretation valid? These types of statements will often leave the reader questioning the validity of many interpretations of ore genesis in the FSU deposits. Also, comparisons with deposits outside of the FSU are often questionable. For example, it would be good to know which specific deposits in the 'southern Appalachians' resemble Sovetskoye and Muruntau. Sukhoi Log is stated to most closely resemble Homestake based upon a similarity in resource tonnage, age, structure, mineralization style, and metamorphic grade. But these deposits are more than 1 billion years different in age, and Homestake is related to sulfidized Paleoproterozoic banded iron formation, whereas no such unit is present in the auriferous Baikal area. Some of the intrusion-related deposits are compared to the 'Alaska-Treadwell ladder-type vein deposit of the Canadian Cordillera', which obviously refers to the Alaska-Juneau and Treadwell deposits of Alaska, USA, where igneous host rocks pre-date gold mineralization by 50-150 my. Many important references are included for each deposit, although there are long sequences of text, such as the regional description of Kumtor on page 72, which lack any referencing. Too often, names of various Russian workers are informally mentioned within the text (i.e. a long list of authors who have published on Muruntau geology, V. Berger's classification of Sb-rich deposits, V. Yevstrakhin and M. Itsikson's descriptions of granite-related gold deposits, etc.), without any clue as to who these people are or where they have published their material.

The weakest part of the book may be the figures, although the author cannot be faulted for some because better figures for certain deposits may not exist. The author should also be acknowledged for revising all figures to include western-style legends, rather than using the typical difficult Russian-style numbered boxes. Most deposit descriptions are accompanied by a local geological map that is quite generalized. For example, the geological map of the Sovetskoe deposit shows swarms of veins surrounded by alteration assemblages and 'tectonic boundaries', but no geologic units. Regional geological/lithological maps would be helpful for each area, but are often lacking and so the local figures cannot be put into any regional context. Even when regional maps are used, they are often less than satisfactory, such as in the case of the Central deposit, where a 10 x 5 km area is covered by a series of lines defining faults, veins, and dikes, but without any regional geological background. The appendix has one geographic map of the entire FSU and locations of all deposits in the book are shown on that map (the same map is shown on the book's front cover at a much smaller size, yet none of the names are readable).

In summary, the book serves an important purpose and will be of use to those individuals considering exploration programs in Eurasia or who want to know more about the economic geology of specific epithermal and orogenic gold deposits in the FSU. The listed prices of $19.99 (US) for paperback and $29.99 (US) for hardcover are very reasonable considering the amount of difficult to obtain information summarized by Levitan. The user should be aware, however, that other sources will be required to obtain a clear understanding of the tectonic and metallogenic belts that host the described gold deposits.