Golden Years: Mineralogical associations in the Casa-Novas orogenic gold deposit in the Ossa-Morena Zone (Portugal)

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Gold mineralisations are frequently associated with orogenic belts where accretionary and collisional processes create favourable conditions for mineral deposit formation. These belts, subject to metamorphism and deformation, host significant gold resources in structurally controlled hydrothermal systems. Among the various models explaining gold transport and deposition, the role of bismuth (Bi)-rich fluids has recently emerged as a key factor in understanding the genesis of many orogenic gold deposits.

Orogenic gold deposits are formed under moderate to high pressures and temperatures ranging from 300 ◦ C to 475 ◦ C, typically between depths of 6 to 12 km. These deposits are often associated with shear zones, faults, and other crustal-scale deformation structures. The gold is transported in hydrothermal fluids as Au-HS complexes, with subsequent deposition triggered by chemical reactions, phase separation, or cooling.

The geological setting of the Casas Novas gold deposit provides an excellent example of orogenic gold mineralization. The region is characterized by complex metamorphic and magmatic processes, with significant fluid-rock interaction. The mineralised zones are predominantly hosted within quartz veins, associated with chlorite and sericite alteration, indicating a hydrothermal origin.

Recent studies emphasize the importance of bismuth in gold scavenging and deposition. Bismuth acts as a key carrier for gold, forming Au-Bi alloys and bismuth tellurides during the cooling of hydrothermal fluids. Experimental studies on the Au-Bi phase diagram indicate that gold remains dissolved in Bi-rich melts at elevated temperatures but precipitates as native gold upon cooling below _~371 ◦ C, with further stabilization at _~116 ◦ C. At Casas Novas, gold mineralization is closely associated with bismuth-bearing minerals such as maldonite (Au2Bi), hedleyite, and native bismuth. These phases occur within arsenopyrite and loellingite assemblages, suggesting that gold was initially transported as a Bi-Au melt or complex before being deposited in response to temperature reduction and sulfidation reactions. The precipitation of gold in orogenic systems follows several key mechanisms: i) Cooling and Phase Separation – As hydrothermal fluids migrate through shear zones, they cool, causing gold to destabilize and precipitate in quartz veins and shear-hosted structures; ii) Bismuth Transport and Gold Scavenging – Bismuth-rich melts effectively concentrate and transport gold. The interaction of Bi-melts with sulphides such as arsenopyrite leads to the exsolution of gold, often as nano-scale inclusions; iii) Sulfidation Reactions – The transformation of loellingite to arsenopyrite during retrograde metamorphism is accompanied by the release and redistribution of gold. Our findings highlight that this Bi-Au interaction occurred in the CasasNovas gold deposit.

The metallogenic model for gold deposits in the Casas Novas region aligns with global studies emphasizing bismuth as a critical agent in gold transport. The presence of Bi-rich minerals, coupled with the observed temperature-dependent gold precipitation, supports the hypothesis that gold was scavenged by bismuth-rich orogenic fluids and later precipitated due to phase separation and sulfidation. This model enhances the understanding of orogenic gold systems and has implications for future exploration strategies targeting Bi-associated gold mineralization. Acknowledgements: This work was funded be the FCT Portuguese National Science and Technology Foundation projects UIDB/04683 and UIDP/04683.

Mots-Clés: Orogenic Gold Deposit, Bismuth, Escoural Casas Novas Deposit, Gold.