

# Precious metals and heavy minerals studies in the stream-sediment and pan-concentrate samples from Bannu Basin, Khyber Pakhtunkhwa, Pakistan

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## Abstract

Stream, pan-concentrate and Quaternary sediment samples from the Kurram River, and its tributaries (Tochi, Gambila, Kashu etc.) in Bannu Basin were studied in the perspective of gold, silver, base and other precious metals and heavy minerals. A total of 292 samples including 185 of stream sediment, 46 of pan-concentrate and 61 of Quaternary sediment samples were collected from outlet points of watersheds representing at least more than 15 km<sup>2</sup> drainage basin generated through GIS 10.1 software from DEM data. The gold grains encountered in the pan-concentrate samples were studied for knowing its morphological characteristics under stereo-microscope. The stream sediments, pan-concentrate and Quaternary sediment samples were treated in the geochemistry lab for analysis through atomic absorption to determine concentration of gold, silver and base metals. The pan-concentrate samples were studied for heavy minerals content under stereomicroscope.

Stereo-microscope was used to describe morphological features and parameters of gold grains were noted both qualitatively and quantitatively. Gold grains from all the samples ranged in size from 70 µm - 10 µm along their longer dimension. Gold grains display abundant abradational features such as pitting, etching, grooves and cavities, folding, with primary features only rarely preserved. Morphological parameters like flatness ratios (ratio of length and breadth to thickness), roundness, degree of bending, shapes on preferred lying sides and surface textures etc. indicate that the grains have undergone appreciable transport (hundreds of kilometers) from the source region.

Geochemical concentrations of 10 precious and base elements were determined by standard atomic absorption techniques in all the 292 samples. In stream sediments the concentration ranges in ppm were: Au (0.01-1.91), Cu (0.002-1.13), Zn (0.001-1.75), Cr (0.001-3.38), Ag (0.0015-0.319), Co (0.003-0.95), Ni (0.002-9.11), Pb (0.001-1.71), Cd (0.001-0.44) and Mn (0.483-17.99). The ranges of elemental concentration in the pan-concentrate samples in ppm were: Au (0.009-5.14), Cu (0.003-2.46), Zn (0.14-1.1), Cr (0.28-3.78), Ag (0.03-2.7), Co (0.02-0.63), Ni (0.01-2.324), Pb (0.004-0.65), Cd (0.001-0.11) and Mn (1.37-21.45). The ranges of elemental concentration in the Quaternary sediment samples in ppm were: Au (0.002-0.5), Cu (0.007-0.98), Zn (0.02-2.02), Cr (0.02-1.93), Ag (0.001-0.43), Co (0.004-0.513), Ni (0.006-2.78), Pb (0.002-0.77), Cd (0.003-0.19) and Mn (1.63-18.98).

The heavy mineral suite in the pan-concentrate samples from the study area, as determined with the visual inspection and stereo-microscopy, includes magnetite, garnet, zircon, epidote, amphibole, tourmaline, apatite and monazite, in decreasing order of abundance, along with minor amounts of gold, rutile, ilmenite, spinel, olivine, pyroxene and chromite.