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A GEOCHEMICAL RECONNAISSANCE OF THE UTUADO BATHOLITH AND VICINITY, PUERTO RICO

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The accompanying maps (plates 1-6) represent the results of a stream-sediment survey covering approximately 600 km^2 in the vicinity of the Utuado batholith, a granodiorite pluton of Late Cretaceous age (mapped as TKp) that crops out on the northern flank of the Cordillera Central in west-central Puerto Rico. All the known porphyry copper deposits in this area occur near the southern margin of the batholith. The deposits are in quartz-diorite porphyry stocks of Eocene age (also mapped as TKp) that have intruded the batholith or the volcanic rocks adjacent to the batholith (Cox and others, 1973).

Most of the stream-sediment samples were collected immediately upstream of confluences, with some being collected midway between confluences. Each sample is composed of six sub-samples collected within 20 m along the active stream channel. The average sample density is approximately one per km^2. Samples were air-dried and seived. The minus 0.25 mm (-60 mesh) fraction was saved for analysis.

Chemical determinations were made for copper, lead, zinc, gold, and molybdenum. Copper, lead, and zinc were extracted in hot HNO_3 solution and determined by atomic absorption spectrophotometry (Ward and others, 1969). Gold was extracted in HBr-bromine solution and determined by atomic absorption spectrophotometry (Thompson and others, 1968). Molybdenum was determined by the emission spectrographic method of Grimes and Marranzino (1968). All concentrations are reported in parts per million (ppm).

The elements whose distributions are shown in the accompanying maps (pls. 1-5) are the elements that have been shown to characterize the soils overlying the porphyry copper deposits of the Rio Vivi district (Learned and Boissen, 1972). The analytical populations of Cu, Pb, and Zn are each divided into four concentration classes whose lower limits are (1) the 95th percentile, (2) the

(2) the 80th percentile, (3) the 50th percentile, and (4) the 1st percentile. The analytical populations of Au and Mo are divided into only three classes of which the third class comprises both classes (3) and (4) above. This modification was necessary because much of the population of Au and Mo falls below our limit of analytical detection.

Among the distribution patterns of the elements shown, copper (pl. 1) best delineates the known deposits and prospects. The other four elements, Pb, Zn, Mo, and Au, provide strong corroborative evidence. The distribution patterns of Pb and Zn (pls. 2 and 3) are broader than that of copper, a feature reflecting the commonly noted "halo" of those elements around porphyry copper deposits. Molybdenum may be a more useful indicator than plate 4 would indicate; the determination of concentrations below 3 ppm should give a clearer picture of its actual distribution with respect to the porphyry copper deposits and prospects. Gold is almost surely a more useful indicator than Plate 5 would indicate; our lower limit of detection, 0.05 ppm, is an order of magnitude above crustal abundance figures. Many of the samples included in the lowest concentration class are therefore probably anomalous. The application of a more sensitive analytical method or the analysis of heavy-mineral concentrates seems advisable for future investigations.

Because ore deposits are almost invariably characterized by suites of elements rather than single elements, multielement data provide a more reliable base for geochemical interpretation. One statistical technique applicable to multielement data is that of factor analysis; we have chosen to apply A. T. Miesch's program (unpublished) of principal component factor analysis to our data. Plate 6 shows the distribution pattern of a factor that includes Cu, Mo, Au, Zn, Ag, and Pb in decreasing order of factor loading. Comparison of Plate 6 with Plates 1-5 indicates that this technique integrates the multielement data rather well.

In addition to the known prophyry copper districts and prospects indicated on the maps, several other areas show favorable geochemical characteristics and therefore warrant further investigation (pl. 6). Those areas include: (1) an extensive area surrounding the Laundry Creek and Copper Creek prospects, (2) an area southwest of the Helecho deposit, (3) an area southwest of Laundry Creek and Copper Creek prospects, (4) an area northeast of the Rio Vivi deposits, (5) an area north of the town of Jayuya, and (6) an area southeast of Jayuya.

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