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GENESIS OF BUTTE COPPER ORES

Mr. Reno H. Sales has prepared for the Butte meeting of the American Institute of Mining Engineers a very thorough description of the ore deposits at Butte, Montana. The general geology of the district, structural features, rocks, rock alterations, superficial alterations of the veins, ground-water, mineralogy of the veins, the ores, vein systems and genesis of the ores are discussed. The paper is accompanied by a series of instructive maps, which show the structural relations of the veins and fissures, important areas of rock alteration and distribution of ore shoots.

The origin of the deposits is believed by Mr. Sales to have been in the granite magma.

"The original source of the ores at Butte was the granite magma. Quartz-porphyry dikes formed a local closing phase of the igneous activity connected with the intrusion of the parent rock, and these dikes structurally and areally are in such close association with the ore deposits that they appear to be a direct factor in the localization of the ores. Heated waters and gases escaping from the cooling magma were the carriers of the metals to their place of deposition. The elements thus transported and deposited in the veins were cilicon and oxygen as SiO_2, sulphur, iron, copper, zinc, manganese, arsenic, lead, calcium, tungsten, antimony, silver, gold, tellurium, bismuth and potassium. Small quantities of potassium are believed to be added to the granite in the sericitization process. Other elements, as sodium, calcium, and manganese, were undoubtedly carried by these solutions, but, as shown by analyses, they were extracted from the granite in the alteration process instead of being added as in the case of the first-named elements.

"The chemical composition of these ascending waters varied in significant particulars as the process progressed. The granite wall rock was decomposed, furnishing much sodium, calcium, and possibly magnesium to the solution. Iron was also freed from the iron minerals of the granite to form pyrite with the sulphur of the invading waters. These interchanges affected the solvent capacity and character of the ore-bearing waters by the subtraction of the acid radical sulphur and the addition of alkaline radicals. While hydrogen sulphide and acidic conditions may have prevailed at the initial stages of ascent, the waters would tend to become alkaline through interaction with the wall rock. Along circulation channels, however, this action would gradually become less pronounced after a barrier built of sericitized granite had been formed bordering the fissures, thus protecting the solutions from further reaction with the fresh