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GEOLOGY AND MINERAL DEPOSITS OF THE GALENA-GILT EDGE AREA, NORTHERN BLACK HILLS, SOUTH DAKOTA

By

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ABSTRACT

The Galena-Gilt Edge area lies at the northeastern edge of the Precambrian core of the Black Hills uplift. It is underlain by three groups of rocks:

1. Mica schists, phyllites, quartzites, quartz schists, and amphibolites of Precambrian age;
2. Dolomitic limestones, shaly and sandy limestones, shales, siltstones, and sandstones of Cambrian (Deadwood Formation), Ordovician (not differentiated here), and Mississippian (Englewood and Pahasapa Limestones) ages;
3. Early Tertiary (Pre-Oligocene) intrusive rocks, which when arranged in order of sequence are hornblende diorite porphyry, pyroxene diorite and pyroxene andesite porphyry, hornblende monzonite and monzonite porphyries, latite porphyry, trachyte and rhyolite porphyries, and rhyolite and spessartite lamprophyre of unknown age relation.

Precambrian rocks show two generations of folding with southerly plunges. The earlier period of folding was marked by the development of a major isoclinal anticline which was followed by a period of superposed folding. Regional metamorphism was penecontemporaneous with the earlier folding. The Deadwood Formation rests on the Precambrian schists with the intervention of a nonconformity. The sedimentary sequence is mostly conformable except for a disconformity between the Ordovician beds and overlying Englewood Limestone. Precambrian rocks and Paleozoic formations,

especially the latter, were structurally disturbed during Laramide tectonism and igneous activity.

The igneous activity, epizonal in depth environment, commenced during the Paleocene (60.5 $\pm$ 3 m.y.) and ended before the Oligocene. The earliest phase was marked by emplacement of a large asymmetric laccolithic body and satellitic sills, dikes, and laccoliths of hornblende diorite porphyry, which were rather passively emplaced and did not involve vigorous disturbance of the intruded country rocks. The large laccolithic body appears to have been influenced by Precambrian shears and fractures during its emplacement. This was followed by intrusions of pyroxene diorite and pyroxene andesite porphyry as small stocks and dikes. Then the stock of hornblende monzonite porphyry with dikes of monzonite porphyry was emplaced. This phase of intrusive activity heralded the beginning of forceful emplacement of intrusives. Emplacement of latite porphyry mainly as stocks and subsequent intrusions of trachyte and rhyolite porphyries marked a period of very forceful intrusions. This period is marked by structural developments including doming, faulting, brecciation, and shearing due to tension involved in the vertical movement of magma. Actually, the vertical movements related to intrusions are the dominant Laramide structures in the area. The next phase was marked by forceful emplacement of rhyolite (hypabyssal) along a northeast trending regional structure. The exact age of the spessartite lamprophyre is not known.

The igneous rocks were probably derived by differentiation from an intermediate parent magmatic body lying in depth. Evolution of the rocks mainly shows a progressive enrichment in soda, potash, and silica.

An abnormal enrichment of potash in the closing phase gave rise to the rhyolites which are more potassic than generally found elsewhere. Excess of potash has obscured the normal trend of evolution. Evolution according to the position of the rocks in the two-feldspar field of the anorthite-albite-orthoclase system diagram ought to have shown soda enrichment towards the end. This phenomenon may be due to hindered reaction as postulated by Noble (1948).

Epithermal and epigenetic mineralizations of gold and silver associated with pyrite, arsenopyrite, tetrahedrite, calaverite, and loellingite, took place in the Gilt Edge area. The mineralization is genetically related to processes of wall-rock alteration. Progressing inward the zones of alteration within or at the flanks of the complex are propylitic, moderately argillic, and strongly argillic. A quartz-pyrite-sericite zone, closely related to the gold-silver mineralization cuts through all these zones. At the center of the complex, jarositic-alunitic zones of alteration (varying in intensity) have developed along shears at the expense of quartz-pyrite-sericite zone of alteration. The quartz-pyrite-sericite zone of alteration and mineralization is controlled mainly by north-trending breccia zones showing arcuate alignments. Subsidiary controls for mineralization are shears, fractures, and joints. Dispersions of several trace elements in the bed rocks of the complex and its flanks show that mercury deposited during the initial stage of hydrothermal process was driven off from the hot center of mineralization. Copper and molybdenum migrated along argillized wall-rocks up to the propylitic flank. Gold and silver dispersions indicate controls by structures such as breccia zones. Arsenic indicates a broad halo over the intensely intruded, altered, and mineralized part of the complex. Mineral paragenesis indicates that the gold-silver mineralization is marked by depletion of copper and enrichment in arsenic, cobalt, and nickel.

Outside the complex and at the flanks of domal structure, mineralizations are predominantly of silver, lead, and tungsten. They occur mostly in the Paleozoic formations (especially Deadwood Formation) and in the vicinity of Deadwood roof pendants in the asymmetric laccolith of hornblende diorite porphyry. The mineralization is predominantly replacement type and is controlled by vertical fractures and cross fractures showing minor displacements.