The Geology of Goldfield, Nevada.*

BY J HN B. HASTINGS.†

Geology—The reconnaissance of the Goldfield district, described in this paper, was made in May and June, 1905; and, though this time was too short for a complete report, the work accomplished may serve as a basis for more thorough future research. Dr. Berkey examined the rocks collected by myself, and I use his classification.

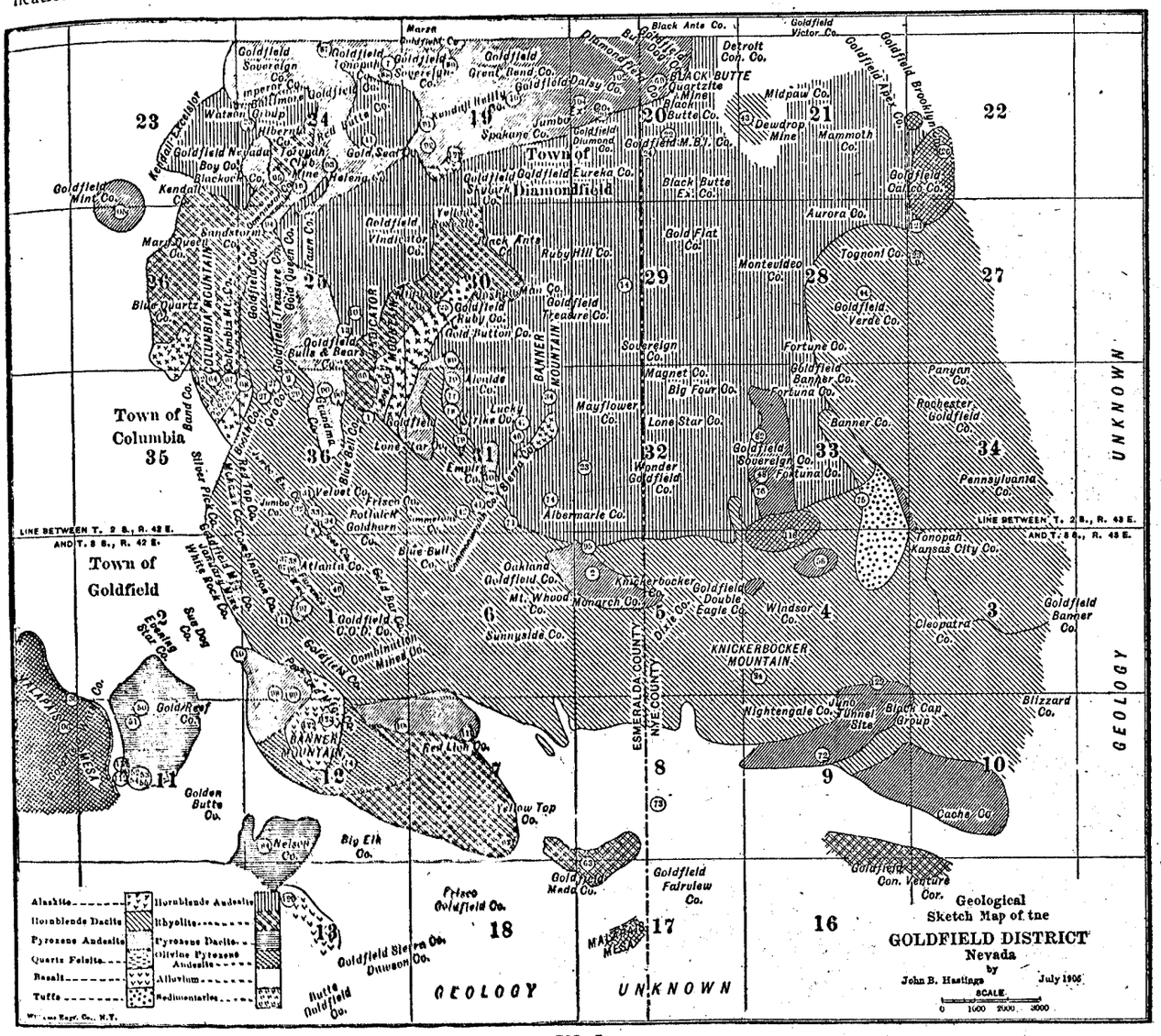

FIG. I.

Goldfield is an eruptive complex, consisting of alaskite (binary granite), hornblende-andesite, hornblende-dacite, rhyolite, pyroxene-andesite, pyroxene-dacite (sometimes containing a small quantity of olivine), quartz-felsite, olivine-pyroxene-andesite, and basalt. Considering this list to be arranged in the order of eruption, the age-sequence of the rocks conforms to Richthofen's law, formulated in 1868. From his observations in Europe and America, propylite, andesite, trachyte, rhyolite and basalt, when occurring together, succeed one another. In a general way, the medium and more acidic rocks precede the most basic—a result supposed by some to have arisen from their relative position beneath the surface, and due to a rude stratification by gravity in the original cooling magma during the older history of the earth, or to the same differentiation occurring during a quiescent (molten?) period preceding eruption, being aided by the ease with which acidic rocks, mixed with water vapors, become fusible. In effect, the more basic and less refractory rocks, from a smelting-standpoint, really seem to need a higher heat, or at least a more prolonged action, to bring them to the surface.

The observed occurrences of other rocks comprise: Two inclusions of sedimentaries (indurated slates or shales, between alaskite and rhyolite) on Columbia and Vindicator mountains; a few very small areas of stratified tuffs, on the Tonopah Club and Desert Rose claims; a large body of tuff in Sections 4 and 33, and, possibly, in other areas of the altered zone, extending from Sections 3 to 36.

The ore-bodies occur in hornblende-dacite and andesite of Knickerbocker mountain, in the rhyolite of Columbia and Vindicator mountains, and in pyroxene-andesite at the Quartzite mine. The whole area shows abundant remains of solfatarism, except in the rhyolite of Myers mountain, and the later pyroxene-andesite, olivine-andesite, pyroxene-dacite, felsite and basalt.

There is extreme silicification of the andesite, dacite and rhyolite along fractures generally northerly and southerly, but also easterly and westerly, forming reefs from 2 to 40 ft. wide, and, in the aggregate, possibly 40 miles long. These

*Abstract of portion of a paper, entitled "The Geology and Petrography of the Goldfield Mining District, Nevada," by John B. Hastings and Charles P. Berkey, published (subject to revision) in *Bulletin* No. 8, March, 1906, Am. Inst. Min. Eng.

†Mining engineer, Denver, Colorado.

zones contain a vast quantity of material resembling hard sugar-quartz, but everywhere interspersed with a greater quantity of the original rock, still dimly showing its porphyritic character. Silicification, less intense, has occurred over large undefined areas.

The silicified reefs are usually barren, but the rich shipping-ores have been found intimately associated with them. My knowledge is insufficient to enable me to say much of the ore-deposits. In the Florence, Quartzite, January mines, and in portions of the Combination mine, it appears as if the areas opened were on rich primary vein-fissures, which are rather small, except where they have been enriched.

In the Sandstorm mine, the rich ore follows a pre-existing northerly and southerly silicious reef, along which the ore occurs at intersections of east-and-west fissures. While distinct brecciation was

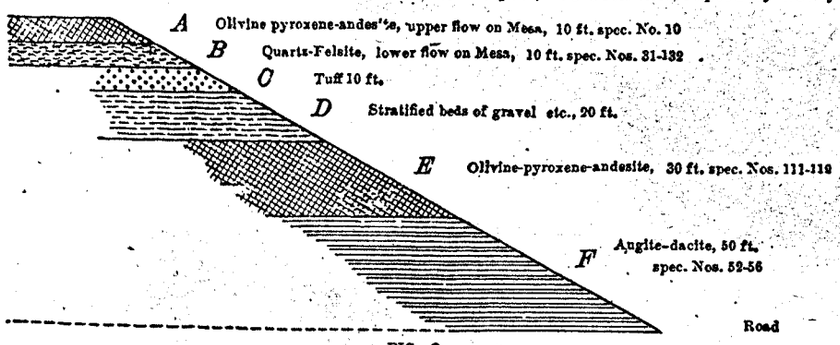

FIG. 2.

not observable at the crossings, in one instance the reef was faulted a distance of 6 ft. by the later fissure. The main ore-bodies were in the silicious reef, the diminishing values extending for 25 ft. along the cross-fissures. The enclosng rock is rhyolite.

The Florence, Combination, and January veins, in the southerly area, striking northwest and dipping east, are crossed by other simultaneously mineralized fissures, striking northeast and dipping northwest, into which the ore is deflected. The northwest fissuring continues, and the ore in the cross-fissures may only follow them for a certain extent, to be picked up again later in the parent fissures. The enclosing rock is dacite.

The Quartzite mine is the representative fissure in the northern end of the district. The vein strikes north 20 deg. west, dips westerly, and is about 5 ft. wide as stoped. A characteristic piece of the enclosing rock from the dump was pyroxene-andesite, having the same blue color and appearance as the southern mineral-bearing dacite, but lacking the quartz. The brownish pyroxene-andesite, west of the quartzite (Sections 19 and 24) is later than the silicified zones, peaks of the latter, too small to be mapped, outcropping like islands in the andesite flow.

In the Florence, Combination and Quartzite, there are cross-fissures younger than the mineralization, which have faulted the veins, and this may be generally expected from the more recent vulcanism.

The tuffs on the Tonopah Club and Desert Rose, cursorily alluded to before, are in shallow detached bodies, occurring as shaly deposits on the present surface, and surviving only in a few depressions. At the Tonopah Club mine several of these small deposits, from 2 to 10 ft. deep, are crossed by the vein-fissure, with a slight faulting. The horizontal tuffs, with bedding-planes at right angles to the fissure, have been permeated and mineralized by the ascending solutions.

There is no proper drainage-system in Nevada. None of the rivers reach the ocean; all sink, either in the channel itself or in the lakes in the great valleys. Probably an important migration of vadose water progresses underground, which in the past, has been interrupted by newly formed volcanic necks. These waters became heated, joined magmatic waters, and rose to the surface; hence, as the rocks cooled and magmatic waters ceased, the springs dried up. Since there has been a succession of eruptive actions in Goldfield, there is also a succession of solfatarism.

Topography—The Goldfield district has the erratic topography of a recent volcanic area, modified but slightly by erosion, the silicified portions forming small peaks by their resistance to the elements.

Columbia mountain, while composed largely on its south end of alaskite, as shown by the Columbia Mountain tunnel, is a rhyolitic neck; Vindicator mountain also is a rhyolitic neck.

Banner mountain, which may also be a volcanic peak, is possibly the product of erosion, since the summit is a mass of hard silicified andesite, and the surrounding basal plain soft andesite and dacite.

Knickerbocker mountain is a great volcanic cone, from which the dacites have flowed northwest and east, partly covering the older hornblende-andesite.

Table mountain (Section 9) on which the Black Cap group and the Juno tunnelsite are located, is a basaltic neck with a later flow of pyroxene-andesite, the hard andesite protecting the soft underlying altered dacite, which forms a ring around the obtruding cone.

In Sections 12, 13 and 14 is another table mountain protected by dacite and basalt, the two effusions being exposed side by side.

Myers mountain, another volcanic neck, at first extruded rhyolite (Section 7). This rhyolite is more basic than (and different, macroscopically, from) the rhyolites of Columbia and Vindicator mountains. Olivine-pyroxene-andesite (Section 12) followed the rhyolite; then pyroxene-andesite (Section 1) and, finally, basalt (Section 12) now crowning summit.

The Malapais mesa, west of Goldfield, extending four miles north, and four miles south, and as much as four miles wide, is a marked example of a table mountain protected by a hard cap. Here lake-beds and tuffs were covered with a thin bed (10 to 50 ft.) of quartz-felsite; the felsite itself was covered soon after by a similar sheet of olivine-pyroxene-andesite.

The pink felsite and black andesite are in marked contrast; the former is a fine example of igneo-aqueous fusion, with steam vesicles up to a diameter of 5 ft.; it may have been an underwater flow. The andesite is comparatively solid. These rocks seem like rivals, and one is struck with the tenacity with which the darker basic rock has so completely covered the lighter acidic rock. The depths of the flows vary, but only slightly. The edges are exposed for many miles on top of the bluff.

A somewhat interesting duplication occurs (Section 11) on the south end of the Wild Horse claim, which, at first, seemed suggestive of a downward faulting on the mesa scarp. This occurrence is explained by Fig. 2. The augite-dacite, *F*, has a slight superficial resemblance to the felsite, *B*; and the olivine-pyroxene-andesite, *E*, to the olivine-pyroxene-andesite, *A*. This last rock preserves its marked characteristics for miles, perhaps the most noticeable being the iron-stained olivines. I could not determine whether *E* and *F* emanated southerly from under the mesa; they disappeared northerly under the wash. Perhaps the olivine-pyroxene-augite occurring in the wells of the Goldfield Brewery & Los Angeles Company, is connected with *E*. There is another nearby outcrop of olivine-pyroxene-andesite, a fine-grained rock, between the Water Tank butte and Mesa (Section 2). The dacite, *F*, is traceable, in detached areas, to and beyond the summit in Section 14, and east of the Lida road.

The mountains in Sections 27 and 34, on the east boundary of the district, are composed of a coarse typical andesite with quartz phenocrysts; that is, hornblende-dacite much younger than the dacites of Knickerbocker mountain. Mapped with the dacites of Knickerbocker mountain are fine-grained altered areas, the composition of which I was unable to determine.