sulphide, and that pyrite and other sulphides are not the natural precipitants in depth, but that precipitation may be due to a more general cause as cooling of uprising solutions.* Recently Lenher,† to whose laboratory researches field workers are deeply indebted, has shown that the alkaline sulphide solutions are highly efficient carriers of gold, that pyrites has no effect on their contained gold and that their gold is readily precipitated by acid waters or by exposure to oxidation. Both these agents may reasonably be assumed to operate only near the surface, especially in volcanic regions. Maclaurin found that the waters of the acid lake on White Island, New Zealand, contained 5.47 per cent. of free hydrochloric acid. Little proof of the existence and wide distribution of acid waters at the earth's surface in solfataric regions is, however, necessary. While the former cause probably operates directly in andesitic regions proper, deposition of gold in the numerous cases in Colorado, Nevada, Translyvania, etc., in which the gold-quartz veins lie in older sedimentary or plutonic rocks, is more likely to be due to oxidizing waters, the influence of which naturally reaches only a short distance beneath the earth's surface.

Recognition of the irregularity and lack of persistence of auriferous ore bodies in andesitic fields is of prime importance to the mining engineer. For such ore bodies not a single ton of ore more than has been actually proved may be assumed.

The Granodiorite Goldfields.

The second group of the classification already outlined includes those goldfields that are apparently genetically connected with granodioritic or closely allied magmas and that occur as a product of their differentiation. This group contains three geographical provinces, viz., Eastern Australia, California, Alaska and the Urals. For the purpose of the present paper they may also be divided simply into (a) lodes in granodiorite and allied rock and (b) lodes in the sedimentary complex through which the granodiorite is intrusive. The relations of the former are simple. Those of the latter are greatly complicated, from the present point of view, by changes in tenor likely to take place when lodes pass in depth from one member of the complex to another.

The deposits of the Eastern Cordillera of Australia are initially dependent on great granodioritic intrusions that have taken place along an axial line of earth folding. Gold-quartz veins may occur either in the igneous rock itself or in the sedimentary strata overlying or adjacent. The habitus of the gold deposits in the north is, in the main, in the granitoid rock; while in the south gold-quartz veins are generally found in sedimentary rocks. Important exceptions to both rules occur and are of special value as evidences of the general genetic connection between the gold deposits of the north and the south, respectively. The general age of the plutonic intrusion is probably late Permo-Carboniferous. All adjacent strata of greater age may therefore carry auriferous veins. Charters Towers in North Queensland, with a production of nearly £29,000,000, is the most important field in the granitoid rocks. Its igneous complex comprises rocks ranging from grey hornblende granite to tonalite, the latter being the predominant rock. The two principal lodes are the Brilliant and the Day Dawn, which have been worked to depths of 2,500 to 2,700 feet. On the whole, the ore has shown a gradual though small diminution of tenor in depth. Similar fields are those of Croydon (Queensland), and Wyalong (New South Wales); neither furnishes any evidence bearing on the point in question.

Considering the number and great importance of the goldfields of Eastern Australia developed in sedimentary rocks the light thrown by them on the general question of persistence of ore bodies in depth is singularly little. Certainly some, as Gympie (Queensland) and Ballarat (Victoria), depend for auriferous deposition on the intersection of lodes or quartz veins and graphitic bands in sedimentary strata, a condition which is not necessarily recurrent at depth. Others, including the majority of the important Victorian fields and the Hargraves field in New South Wales, are developed in tension fractures between unlike beds at the crests of anticlines forming, e.g., the famous "saddle reefs" of Bendigo and Castlemaine. In these fields saddle reefs are successively met with in depth when sinking on an anticlinal axis, so that a condition ensues very different from that met with when considering the filling in depth of a single continuous fissure. But the experience gained on these formations all tends to show that the lower saddles are not nearly so rich or so large as those above. At Bendigo mining operations were carried to 4,614 feet below the surface in the New Chum mine, but it is very probable that, taken as a whole, work on the Bendigo field below 2,500 feet has not been profitable. Certainly the tenor of the ore has decreased in depth.

In the California-Alaska belt of gold lodes, which are apparently dependent on granodiorite magmas, the various Mother Lode mines and the Alaska-Treadwell group in south-eastern Alaska are the most important. The latter are still shallow and are of no help in the present discussion. Many of the Mother Lode mines, especially in Amador county, are nearly 2,000 feet deep, and some, as Kennedy (3,650 feet), Gwin (2,650 feet), and South Eureka (2,850 feet), have reached much greater depths.

The Mother Lode is a fissure zone that may be traced from Bridgeport in Mariposa county to near the northern boundary of Eldorado county, a distance of 120 miles. In many places it is a solid lode 100 feet wide, but often it is merely a shattered zone in which numerous quartz stringers are developed. It is undoubtedly due to major faulting developed along a line parallel with the axis of the Sierras during the uplift of those mountains. The faulting has selected the softest beds (Mariposa slates) of the sediments and has uplifted them for great distances.

So far as my three months' examination of the Mother Lode permitted, I have not been able to make out any appreciable diminution in tenor in depth. Many mines have certainly "bottomed" the ore in given fissures at depths less than 2,000 feet, but it often happens that two or more parallel lodes occur within the Mariposa slates, and that when one becomes barren a hanging wall or footwall lode may carry ore to much greater depths. In few auriferous regions is cross-cutting from wall to wall of the lode channel more necessary; in few has less been done than along the Mother Lode. The mines of Angels Camp are often instanced as evidence of the occasional non-persistence of Mother Lode mines in depth, but, assuming for the moment that no ore occurs there in depth, their evidence cannot be admitted against Mother Lode mines. They are, it is true, on the line of the Mother Lode fissure zone, but from the Hardenburg mines, south of Jackson, to near the Rawhide mine, south of Tuttletown, the Mother Lode fissure zone, keeping a straight course, leaves the Mariposa slates, which curve to the west through the Gwin mine and

*Maclaren, Gold, London, 1908, pp. 38, 78, etc.
†Econ. Geol., Vol. VII., 1912, p. 744.