NOTES ON THE CRYSTAL BEDS OF TOPAZ BUTTE.

BY WALTER B. SMITH.

A few amazonstone and smoky quartz crystals, with occasional associations of other minerals, have been found on Pike's Peak proper, a few more about its base at Bear Cr., Crystal Park, Specimen Rock and Cheyenne Mt., but by far the greater number of specimens labeled *Pike's Peak* have been obtained from the so-called crystal beds, about twenty miles northwest from that point. This locality has been known for twenty years, but as it is somewhat difficult of access except by going with a camp outfit, but few persons have visited the place, aside from an occasional crystal hunter and the ranchmen living in the vicinity, who, with varying success, for twelve or fifteen years have dug and sold an annual crop of specimens.

Topaz Butte, a sharp point five miles due north from Florissant, marks the southern limit of the crystal beds. Its summit rises about a thousand feet above the surrounding valleys, and is the highest of a chain of similar bare granite points extending some distance to the north, and known locally as the Crystal Peaks, while Topaz Butte itself, though included as one of the peaks, is often called the "Sore Thumb," or by some "Cheop's Pyramid." A rectangle, beginning at Topaz Butte and running six miles north along the above ridge, and extending three miles eastward, will include most of the pockets from which the beautiful and well known amazonstone and smoky quartz crystals have been taken. The pockets that have been found within these boundaries—probably more than a thousand in all—are generally two to four feet deep, but in the largest one crystals were found to a depth of fifteen or twenty feet. These pockets were originally crystal lined cavities of varied forms and sizes occurring in the granite, but owing to the caving in of the walls through

disintegration of the surrounding rock, or, as suggested by Cross,* through movement of the rock-mass as in folding or faulting, and the consequent dislocation of the cavities, many crystals are found detached and lying loose in the dirt, often badly bruised or broken, particularly the large quartz crystals. The greatest number of crystallized minerals ever taken from a single pocket in this region would aggregate fully two tons in weight.

Quartz of all shades from colorless (rare) to black and nearly opaque crystals is the most abundant mineral. No rare planes have been observed. Several rhombohedrons, the tetragonal pyramid $2P2$ and one or two gyroidal planes are not uncommon in combination with the ordinary prism and rhombohedron. Some very large crystals have been found: one taken from a pocket about ten years ago is between four and five feet long, but in several pieces. Several thick entire crystals weighing about 100 lbs. each have also been obtained, from one of which a ball, free from flaws, of uniform color and six inches in diameter could be cut. Crystals of regular shape like those from Switzerland, and many other localities, are very rare, but a tapering form is common, owing to alternating prism and pyramidal planes. Ordinarily the color is deeper at the apex of the crystal.

A large amount of quartz from these pockets has been cut for jewelry and ornamental articles by lapidists both in this country and in Germany. The price paid is from 50c. to $2.00 per pound, depending upon the quality of the stone and the demand for it.

Microcline ranks next in abundance to quartz. The amazonstone variety, when of fine shades of green, is the most prized. White, gray and pinkish crystals also occur. Simple crystals are very numerous, having the usual combination $\infty\breve{P}\infty$, ∞P, OP, $\overline{P}\infty$ often with $\infty\breve{P}3$, $2\overline{P}\infty$ and $2\breve{P}\infty$ in addition. I have not observed the macropinacoid ($\infty\overline{P}\infty$) on any of these crystals, though it occurs rarely at another place in the Pike's Peak region (Devil's Head).

* Bulletin 20. U. S. Geological Survey.

Twin crystals. The most abundant are *Baveno twins*, sometimes of a large size; a white one found a year or two ago, now in the collection of the Colorado Scientific Society, is $6\frac{1}{2} \times 6\frac{1}{2} \times 14$ inches and weighs 45 lbs. Fine green ones 4 and 5 inches square and a foot or more long have also been found; they are, of course, much rarer than the smaller twins. *Manebach twins* are not uncommon, but they never equal the large Baveno twins in size. The larger crystals are very apt to come apart along the twinning plane, unless on a pretty firm base. A few crystals have been found twinned according to two laws—parallel to OP (Manebach law) and also parallel to $\infty\breve{P}\infty$ (common in albite)—producing double Manebach forms. *Carlsbad twins* are less numerous here than either of the above kinds, while at the Devil's Head locality,—twenty miles north—they are the most common. Often the development is such that the faces OP and $\overline{P}\infty$ lie apparently in the same plane producing a form like the simple crystals. Occasionally one is met consisting of three individuals, or a crystal with the middle portion only reversed.

Another common variety of twins of this species has the twinning plane $\infty\breve{P}\infty$ (mentioned under double Manebach twins). The angle from the brachipinacoid to the basal plane is so close to 90° however that the twinning is not very conspicuous, but is generally shown by a suture line on OP and a reëntering angle along the prism.

Sometimes a pocket is found in which the microcline crystals have a coating of white kaolin a millimeter or so thick, but in most cases the feldspars and quartzes especially, are covered more or less with iron oxide, which is usually removed by the collectors or dealers, by boiling the specimens in a solution of oxalic acid till the iron is dissolved and then soaking them in water to remove all traces of the acid.

Some of the choicest colored amazonstone has been cut into gem and ornamental stones, but it is of little value for this purpose. Groups of amazonstone and quartz

crystals are often of great beauty when the minerals are of fine color; such groups are often large, weighing from 50 to 100 lbs.

As a rule feldspar crystals from the same pocket are similarly modified and vary but little in color. Green crystals may occur in a pocket but a few feet from one containing white or gray crystals, but green crystals and white ones are never found in the same pocket. Some amazonstones are white-capped, to be sure, but this is probably owing to a secondary growth on planes—particularly on OP and the prism. The color of amazonstone crystals is always darker on the faces of ∞P.

Some pockets have been found containing quartz only, others with microcline alone, but in most cases they occur together and often with some of the minerals about to be mentioned.

Albite is common in radiating mammillary forms, grouped about the base of quartz and microcline crystals —often adding greatly to the beauty of the specimens. It is rare in good separate crystals, though sometimes found of rather small size—not exceeding ¾ of an inch across—having the combination OP, $P\infty$, $\infty\breve{P}\infty$; sometimes ∞P is shown as a very small face but it is usually crowded out by $\overline{P}\infty$, or, when present by $2\overline{P}\infty$, meeting the base OP. Simple crystals are more numerous than twins—something uncommon with this species. Twins, when they occur, are of the ordinary kind, twinned parallel to the brachypinacoid.

Göthite is a secondary mineral in the pockets, rarely occurring in good crystals, but common in mammillary forms radiating from quartz — frequently forming an almost perfect sphere around the apex of the crystal. It also forms on the feldspars and on fluorite. Also, much rarer, in groups of long bright tabular crystals some of which are terminated by the basal plane OP? Another form is mentioned under pseudomorphs. In many pockets göthite has had several periods of deposition; the

different generations being beautifully shown on some pieces. An interesting specimen of this kind, in the collection of Whitman Cross, originally formed around a quartz crystal, which, from some cause has been removed and its cast filled by a second generation of göthite.

Limonite is common in nearly every pocket as a thin crust covering the other minerals, also as pseudomorphs, and, in a few large pockets, in thin stalactites, several inches long.

Hematite occurs most abundantly as pseudomorphs (mentioned below) and, like limonite, sometimes as a crust, also, rarely, in short round columns made up of thin plates piled one upon another.

Turgite is occasionally found as a black shining botryoidal crust on feldspars and quartz.

Fluorite in twins and simple crystals, with a combination of cube and octahedron planes, has been found on quartz and microcline quite abundantly in some pockets. It is a secondary mineral. Some crystals are 3 or 4 inches across but usually rough, presenting etched surfaces. The colors are white and various shades of green and purple, often combined in the same crystal.

Columbite. An analysis of columbite, from this locality has been published by J. L. Smith.* It is of rare occurrence, but occasionally a pocket is struck with quite good small bright crystals implanted on amazonstone.

Cassiterite. This is another rare species, having been found in but two pockets. The pieces I have seen are rough but have a few distorted crystal faces. A few very good twin crystals, an inch or more long, have, however, been obtained.

Muscovite. Many pockets contain more or less of this mica, generally attached to amazonstone, but good crystals are not often met; probably the best one yet found is about 2 inches long and more than an inch through. It has

* Am. J. Sc., III., xiii., 359, 1877.

a fine, natural basal plane and the prism planes are well defined, but somewhat irregular.

Pseudomorphs after siderite. Attached to quartz or microcline in many pockets are found crystals of limonite, hematite, or göthite, having the form of perfect siderite crystals. For some reason, perhaps because the faces are not curved, these are sometimes referred to pseudomorphs after calcite. A number of crystals from different pockets, well adapted for measurement with the hand goniometer gave results for R∧R varying not more than one degree from 107° the angle of siderite. The rhombohedron R is the general form; on some crystals in connection with it the basal plane O appears. The angles of some of the hematite pseudomorphs are as sharp as they could have been on the siderite itself. Limonite in most cases retains the perfect cleavage of the original mineral. Göthite pseudomorphs are not plentiful. Outwardly they resemble limonite, but, on being broken reveal a radiated structure and their characteristic color.

Pseudomorphs after calcite. Mr. J. G. Hiestand called my attention to these interesting pseudomorphs which have been obtained from but one cavity. The largest one is a scalenohedron nearly 2 inches long, made up of the planes R3. The broken ones show a shell of hematite, sometimes covered with a thin crust of turgite, the interior being either cavernous or filled with göthite.

The original calcite, as well as most of the other species, crystallized at a later date than quartzes and feldspars, though some of these show two or more periods of growth.

Phenacite and Topaz. On the west side of Crystal Peaks, pockets have been found scattered over an area equal perhaps to that on the eastern slope, but they are fewer by far in number. Phenacite and topaz have been found in three of these pockets, while neither mineral has been observed on the eastern side, though the formation, conditions and associations are apparently similar.

A pocket found by Mr. Transue, in 1884, on a débris-covered slope about one-half mile northwest of Topaz Butte, yielded the first phenacites and topazes that were found in this region, which have been described by Cross* and the phenacites by W. E. Hidden† with notes and figures by Des Cloizeaux. The minerals associated with phenacite in this pocket are topaz, microcline, quartz (smoky and white), albite, fluorite, limonite (pseudomorph after siderite), columbite (very rare) and biotite. At this pocket the writer found fragments of topaz, albite, quartz and microcline with phenacites attached, and a number of loose lenticular crystals having the development described in the papers referred to above. More phenacites are found on albite than on all the other species; on one piece were fourteen distinct crystals on a surface about three-quarters of an inch square. One small but very perfect twin which has not been studied was also found. It is attached to quartz and consists of two lenticular crystals about 3^{mm} in diameter crossed at an angle of about 90°.

The largest phenacite ever found in this locality is a rough crystal 15^{mm} across. Most crystals are colorless, but those that have been entirely imbedded in gangue are generally of a faint wine color; one was observed having a smoky bluish tinge. All phenacites attached to microcline, here, as well as at the Specimen Rock locality are on the green or amazonstone variety.

It is evident that some of the phenacites crystallized contemporaneously with the quartz and feldspar, as they have been observed in the interior of smoky quartz and of amazonstone crystals, these minerals showing no evidence of a secondary growth. Phenacites have also been found half in quartz and half in microcline where the two minerals are in contact. Other crystals seem to be of a later generation than the original minerals of the cavity, as they occur slightly attached to amazonstone, to albite coating

* Bulletin No. 20 U. S. Geological Survey.
† Am. Jour. Science, Sept., 1886.

microcline, and entirely imbedded in the limonite crust on some feldspars.

Topaz occurs in the same manner as phenacite and closely associated with it. It has, perhaps, a greater affinity for amazonstone, on prism planes of which are frequently many topazes, lying apparently in all directions; a closer inspection, however, shows that many crystals are in reality arranged in definite positions in regard to the amazonstone. The most common position is that in which the vertical axes of the two species correspond. Other cases occur in which the cleavage planes OP of both minerals coincide. Still other crystals of topaz have the vertical axis parallel to the brachydiagonal of the amazonstone.

I wish to express my obligations to Mr. Houghton, of Florissant, for information concerning the locality, and to his son Mr. J. S. Houghton, for kindly going over the ground with me and pointing out the most interesting places.