Nolan,

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by limestones that contain Carboniferous fossils.[8] The quartzite and chert are also believed to be of this age, although not themselves fossiliferous. Emmons correlated similar quartzites in the Independence Range, north and west of Tuscarora, with the Weber (?) quartzite of the Eureka section, also of Carboniferous age.[9]

Bedded series — The rocks that constitute the bedded series include both pyroclastic rocks and lava flows. The proportions in which the two varieties are present differ from place to place, but on the whole the pyroclastic rocks appear to be considerably more abundant.

The pyroclastic rocks include both volcanic breccias and tuffs. The breccias are in general more abundant in the western and northwestern parts of the area mapped, where fragments an inch or more in diameter may be observed; to the east and south the fragments are smaller, and the rocks are typically tuffs. Most of these rocks within the mineralized area are pale gray, but locally greenish or gray-green tints predominate, especially to the west and northwest. In many places the bedding planes are obscure; in others they are marked by changes in grain size or by a pronounced easy fracture. Locally fine-grained quartz has been introduced along the bedding planes in the tuffaceous rocks. The rock fragments in the breccias are composed almost exclusively of altered fine-grained volcanic rocks; crystal fragments of both feldspar and quartz are also found.

The microscope shows clearly the pyroclastic nature of the rocks, as well as the intense alteration they have undergone. All the specimens examined are composed chiefly of potash feldspar, quartz, and a fine-grained mineral that is probably the clay mineral dickite. All the large feldspar crystals in the rocks are complexly twinned potash feldspar (see p. 26), which is probably an alteration product, as identical potash feldspar is equally abundant throughout the matrix, even in places where the outlines of former glass shards may be recognized. Commonly the feldspar itself has been attacked and replaced by the supposed dickite or less commonly by quartz. Rutile and other titanium minerals are universally present. Small quantities of sericite are found in some specimens, and rocks collected from the western part of the region contain a green chlorite and locally calcite. Pyrite occurs in a few specimens, but in most

[8] Nolan, T. B., Unpublished report on the Mountain City mining district, Nev.
[9] Emmons, W. H., op. cit., p. 58.

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it cannot be recognized, probably because it has been removed by surface oxidation. At the surface the pyroclastic rocks contain more or less of a clay-like mineral that is quite different optically from the dickite. This is optically and chemically similar to fine-grained sericite. In a pit at the south end center of the Comstock No. 10 claim this mineral forms the bulk of the rock.

Lava flows are interbedded with the pyroclastic rocks. They are commonly much altered porphyritic rocks with a dense groundmass, which is locally flow-banded. The less altered facies, which is found to the west and north, is greenish brown and contain numerous small dull feldspar phenocrysts and less abundant and smaller dark phenocrysts, most of which are apparently biotite. In the southern part of the area studied the flows are practically all light gray to buff and only the outlines of former feldspar phenocrysts can be recognized. As with the pyroclastic rocks, a soft claylike mineral is abundant at the surface, especially in the phenocrysts.

The sections of the less altered flows show phenocrysts of albite and pseudomorphs of chlorite, calcite, iron ore, and sericite after biotite and, less commonly, hornblende. The groundmass, which in many specimens was originally a glass, has been recrystallized to a fine-grained mixture of feldspar (probably albite) and quartz. In the highly altered rocks of the southern part of the area the albite has been completely replaced by potash feldspar, both in the phenocrysts and in the groundmass. This, with quartz, small quantities of dickite (?), rutile, and apatite, makes up the whole rock.

Quartz appears to have been originally absent from all the lava flows and, where now found, has been deposited by mineralizing waters. It is also uncommon as a primary constituent of the pyroclastic rocks. The potash feldspar, which is so abundant in the bedded rocks, also appears to be entirely a product of mineralization. These rocks must therefore have been andesites at the time of their eruption, either albite andesites, if the albite phenocrysts found in the less altered facies can be considered primary, or, more probably, normal andesites if the albite is secondary. (See p. 25.) The prevailing light color of the pyroclastic rocks and the flows has, however, in the past caused them to be classed as rhyolites,[10] but there is no doubt that the present abundance of quartz and potash feldspar is not an original feature.

[10] Emmons, W. H., op. cit., pp. 58–60.

chlorite, calcite, and pyrite has not been generally recognized.

To the southeast the bedded rocks have been converted to an assemblage of quartz, adularia, and dickite(?). In many places these minerals have been introduced in such quantities that most of the original texture has been destroyed; locally it is difficult or even impossible to distinguish between flows and pyroclastic rocks. The outlines of the plagioclase crystals in the original rock remain, but the plagioclase has been converted to the potash feldspar adularia. Commonly the matrix is completely replaced by a fine-grained aggregate of quartz and adularia. Small quantities of chlorite and of titanium minerals provide the only indications that dark minerals were once present. Locally adularia has formed crystals a quarter of an inch or less in diameter along the walls of joint planes in the altered rock, and this crystalline material is commonly associated with terminated quartz crystals. A fine-grained clay mineral, which is probably dickite, occurs locally upon the corroded surfaces of the crystalline adularia; it is also found in rounded nests within the adularia that has replaced the original phenocrysts, and less commonly in the groundmass.

The adularia is a rather pure potash feldspar, as is shown by the following two partial analyses by J. J. Fahey of the United States Geological Survey:

	1	2
K_2O	13.38	14.45
Na_2O	.96	.83
Li_2O	.06	n. d.
Rb_2O	.04	n. d.
Cs_2O	.00	n. d.

Both of these analyses were made on coarsely crystalline adularia collected from the ridge north of the Modoc tunnel. Miss Jewell Glass, of the Geological Survey, determined the following optical properties on material represented by analysis 2: $\alpha = 1.516–7$, $\beta = 1.520–1$, $\gamma = 1.521–2$; biaxial (—); wavy extinction; 2V variable from medium to small; twinning shadowy, locally suggesting microcline.

One of the highly adularized rocks, which shows a faint banding in hand specimens, was collected 300 feet north of the open stope on the Bull Run claim. It was analyzed by J. J. Fahey, of the Geological Survey, with the following result:

SiO_2	74.75	Na_2O	.66
TiO_2	.40	K_2O	8.21
Al_2O_3	13.61	Li_2O	.03
Fe_2O_3	.83	Rb_2O	.02
MgO	.21	H_2O	1.58
CaO	.02		100.32

0.4% = 8 lb/ton @ $0.295 = $2.36/ton

A thin section of the rock shows scattered outlines of old feldspar crystals now replaced by adularia or by a fine-grained mixture of sericite and quartz, set in a fine-grained aggregate of adularia, quartz, and dickite(?). Strings of tiny dots and slightly larger aggregates of a titanium mineral, probably rutile, are found throughout the rock. Quartz veinlets, locally bordered by tiny rhombs of adularia, are rather abundant. The rock might have been originally either a tuff or a flow.

Calculations based upon an assumed content of 5 percent of sericite show that this rock contains in addition 36 percent of quartz, 45 percent of molecular orthoclase, 7 percent of albite, and 7 percent of dickite. The ratio of K_2O to Na_2O is lower than in the coarsely crystalline material, perhaps indicating that this adularia contains a higher content of the albite molecule in solid solution because of the replacement of a pre-existent albite-rich plagioclase.

The intrusive andesites also show both the chloritic alteration and the alteration characterized by adularia, but the two types are not spatially distinct, as in the bedded series, nor is either alteration as intense. Almost all the specimens of the intrusive andesite collected show the development of some chlorite and calcite, especially in the dark minerals, and small patches of albite replacing the original calcic andesine were commonly observed. A few specimens thought to have been originally andesite show a fairly complete replacement by adularia, quartz, and dickite(?). This alteration appears to have been of rather slight extent, however, and there is some evidence that it may have been restricted to the vicinity of the ore bodies.

The differences between the alteration of the bedded series and that of the andesite are believed to be most easily explained by the differences in fracturing within these rocks. The wide shear zones in the bedded series, combined with the relatively high porosity of the pyroclastic members, would permit widespread and easy penetration by the solutions that caused the alteration; the narrow fractures and dense texture of the andesites, on the other hand, would permit rapid circulation and reaction only in the immediate vicinity of the fractures.

The relations between the two kinds of alteration suggest that the quartz-adularia-dickite(?) aggregate, whose introduction may be called "adularization," was commonly superposed upon a pre-existent aggregate introduced during "propylitization." The minerals formed during propylitization—notably chlorite, he United States, by products

um slag TiO2 content (estimated)	Rutile Gross weight	Rutile TiO2 content (estimated)
105,483	117,376	113,017
93,683	135,883	130,191
86,945	153,457	147,158
100,591	112,856	108,544
-------	(3)	(3)
-------	21,414	20,409
(3)	728	659
-------	(4)	(4)
-------	(3)	(3)
-------	25,275	23,988
100,591	160,273	153,600
98,075	129,668	124,811
-------	(3)	(3)
(3)	22,001	20,987
(3)	(3)	(3)
-------	472	451
-------	(3)	(3)
-------	33,561	31,934
98,075	185,702	178,183

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hipments, by industries

1967	1968	1969
61.9	60.7	58.5
14.6	14.9	17.0
2.7	2.4	2.3
2.8	2.9	2.6
1.4	1.4	1.3
2.0	2.1	2.3
1.1	.8	.9
1.9	2.1	2.0
5.1	6.0	6.2
6.5	6.7	6.9
100.0	100.0	100.0
57.5	56.5	54.3
17.2	17.4	19.5
3.1	2.7	2.6
3.2	3.3	3.0
1.6	1.6	1.4
2.3	2.4	2.6
1.4	1.0	1.1
2.2	2.4	2.4
6.0	6.9	7.1
5.5	5.8	6.0
100.0	100.0	100.0

STOCKS

Industry stocks of rutile decreased 15 percent to 184,000 tons, equivalent to about 1 year's supply at the 1969 consumption rate. Ilmenite inventories decreased 5 percent, and stocks of titanium slag decreased 13 percent. Yearend sponge-metal stocks of producers and melters were 1,908 tons, 27 percent less than beginning stocks. Titanium scrap held by melters and fabricators was 4,727 tons compared with 4,434 tons at the end of 1968. Stocks of composite and pure titanium dioxide held by producers at yearend were 100,850 tons, up 7 percent from the first of the year.

Table 7.—Stocks of titanium concentrates in the United States, Dec. 31

(Short tons)

Year and stock	Ilmenite		Titanium slag		Rutile	
	Gross weight	TiO_2 content (estimated)	Gross weight	TiO_2 content (estimated)	Gross weight	TiO_2 content (estimated)
1968:						
Mine	(1)	(1)	-------	-------	(1)	(1)
Distributor	r 209,013	r 130,737	-------	-------	17,142	16,454
Consumer	682,000	373,350	119,746	84,743	201,375	193,388
Total	r 891,013	r 504,087	119,746	84,743	218,517	209,842
1969:						
Mine	(1)	(1)	-------	-------	-------	-------
Distributor	247,229	146,223	(2)	(2)	(2)	(2)
Consumer	600,010	330,515	103,733	73,550	184,086	177,243
Total	847,239	476,738	103,733	73,550	184,086	177,243

r Revised.
[1] Included with "distributor" to avoid disclosing individual company confidential data.
[2] Included with "consumer" to avoid disclosing individual company confidential data.

PRICES

Concentrates.—Prices for ilmenite remained the same as those in 1968. Domestic ilmenite with 60 percent titanium dioxide (TiO_2) content was quoted at $30 to $35 per short ton. Imported ilmenite containing 54 percent TiO_2, f.o.b. Atlantic ports, was quoted at $20 to $21 per long ton of contained TiO_2. The quoted price for imported rutile (96 percent TiO_2) rose in several steps from $125 to $160 in August, where it remained at yearend. Titanium slag (70 percent TiO_2) was raised to $45 per long ton.

Manufactured Titanium Dioxide.—The basic price of anatase grades of titanium dioxide pigment was raised 1 cent per pound. Quotations on other pigment grades remained the same. Yearend quotations from Oil, Paint and Drug Reporter were as follows:

	Price per pound
Anatase, chalk-resistant, regular and ceramic:	
Carlots, delivered	$0.265
Less than carlots, delivered	.270
Rutile, nonchalking, bags:	
Carlots, 20 tons, delivered East	.285
Less than carlots, delivered East	.295
Titanium pigment, calcium-rutile base:	
30 percent TiO_2, bags:	
Carlots, 20 tons, delivered	.09375
Less than carlots, delivered	.09875
50 percent TiO_2, bags:	
Carlots, 20 tons, delivered	.14375
Less than carlots, delivered	.14875