Diameter of unmasked usable portion of crystal 3 mm.
Objective, Leitz 35 mm. with iris stopped down to reduce scattered light.
Ocular, Leitz number 1.

The photograph was made by focusing the microscope for infinite image distance, using a camera having a 25 cm. lens focused for infinite object distance. Of course, the image could be projected to the plate by means of the ocular only. The exposure for each optic axis position with the sodium Lab-Arc was 20 minutes. The exposure for the acute bisectrix spot was 45 seconds. Fast panchromatic press film was used.

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MORDENITE FROM TINTIC, UTAH, AND THE DISCREDITED MINERAL ARDUINITE

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INTRODUCTION

While mapping rock alteration in the Tintic Mining district, Utah, a small area was discovered in quartz latite which contained a zeolite originally thought to be arduinite (Stringham, 7). In order to make x-ray comparisons a sample of arduinite from the type locality in Italy was secured from the Harvard mineralogical collection, through Professor E. S. Larsen. The Tintic mineral proved to be identical to the type arduinite but it was finally found that the space group and unit cell of "arduinite" was identical with mordenite (Waymouth et al., 8); therefore, this study serves to discredit the species arduinite.

Arduinite was first found in the province of Val dei Zuccanti, Venecia, Italy, by E. Billows in 1912 who named and described it. His original paper could not be secured, but a review in the *Mineralogical Magazine* (5) states, "*Arduinite*, E. Billows, 1912. Two pamphlets both dated Padova 1912, entitled 'Analisi di alcuni minerali del veneto, Nota I, Arduinite, un nuovo Minerale,' one of 11 pages and the other of 14 pages. One of them is stated to be an extract from *Rev. Min. Crist. Ital.*, vol. **xli**; but the paper does not appear in that or in earlier volumes of that periodical." An analysis of arduinite was found in Appendix III to Dana's System of Mineralogy (2) together with a short description and it is here stated that Billows named the mineral after Giovani Arduino, a geologist of the 18th century. Doelter (3) gives the same analysis but states that it is an average of two analyses made by E. Billows. Later Barth and Berman (1) describe the mineral briefly and give optical data and provisional crystallographic data.

The early work was done with arduinite in mind and before x-ray equipment was available, hence the work done on mordenite, other than x-ray measurements, briefly presented here, is perhaps more extensive than necessary.

Field Occurrence of the Mordenite

At Tintic the mordenite occurs over an area about 150 by 50 feet in extent in quartz latite porphyry near the southeastern part of the district. The exact position is a considerable distance from any landmark. However, the road from the Tintic Standard mine to the Eureka Standard mine comes nearest the mordenite locality at a point about 1 mile south of the graveled "Valley" road junction. From here the area is about 300 yards north and 65 yards west and is situated near a low saddle on a very gently south sloping low hill.

The color of the unaltered mordenite is rusty red but microscopic work shows it to be truly colorless, and the red is apparently due to disseminated hematite dust. The individual crystals are long and slender, and packed in bundles which radiate from a central point giving a rosette appearance, the radii of which vary from around 2 mm. to 20 mm. Individual unit crystals are very small. One crystal fragment selected for x-ray work having dimensions of .5mm.×.2mm.×.05 mm. was apparently a single crystal when viewed under the microscope, but a rotation x-ray photograph showed it to be a bundle of 7 distinct units.

In thin section the rosettes are found to be entirely surrounded by quartz which replaces all constituents of the quartz latite. At the outer termination of the rosettes, mordenite needles replace and penetrate the quartz. Occasionally weathering has caused the hematite of some rosettes to alter to limonite and these appear rather brownish. The rosettes commonly are strung out along flow lines of the quartz latite, rarely forming a continuous chain, but usually disconnected with rock between. In several instances connected chains of rosettes were found to cross flow lines at approximately right angles. There seems little doubt that this mineral was formed during a post quartz latite hydrothermal stage.

Optical Determination

Index of refraction of the arduinite and Tintic mordenite gave the following results: Mordenite, Tintic, $\alpha=1.474$, $\beta=1.475$, $\gamma=1.478$; "Arduinite," Italy, $\alpha=1.474$, $\beta=1.476$, $\gamma=1.478$*. The 2V, measured with the Universal stage was found to be near 76°. The optical orientation is, X parallel to c or long dimension of the crystal fragments, Y parallel to a, and Z parallel to b.

* Same values as Barth and Berman (1).

Chemical Analysis

The intimate association of quartz with mordenite necessitated the examination under a high power binocular microscope, of each fragment selected for analysis and apparently pure mordenite fragments were crushed and observed with the petrographic microscope. These precautions led to a final product which seemed to be essentially pure mordenite, except for the ever present hematite dust. A new mordenite analysis is here presented together with the original one by E. Billows for "arduinite."

Table 1

	Mordenite, Tintic Analyst; Lee C. Peck		"Arduinite," Italy Analyst; E. Billows (Doelter, 3)
SiO_2	64.95		49.40
Al_2O_3	11.71		14.57
Fe_2O_3	.62	(+MnO)	2.43
FeO	.41		
MgO	.11		
CaO	4.55		6.57
Na_2O	1.18		11.77
K_2O	1.71		1.54
H_2O+	6.25		13.85
H_2O-	6.20		
CO_2	1.04		
TiO_2	.03		
P_2O_5	.02		
MnO	.20		
	98.98		100.13

Billows' figures are considerably different and since both minerals are the same mineral structurally, their analysis should check more closely. If there had been enough of the type material available, a new analysis of it would have been made. The formula calculated from the Tintic analysis is $(Na_2,K_2,Ca)O \cdot Al_2O_3 \cdot 9SiO \cdot 6H_2O$, which is the same as that given for the type mordenite by How (4).

X-Ray Data

Debye-Scherrer pictures were taken of Tintic and Italian material with identical patterns resulting. Weissenberg pictures of the Italian material were carried out to the 5th layer line giving information which could make the space group either $D^{17}_{2h}-Cmcm$ or $C^{12}_{2v}-Cmc$ and the orthorhombic unit cell dimensions $a_0=18.05$, $b_0=20.42$, $c_0=7.47$Å.

Subsequently these data were found to be identical to the space group for mordenite as measured by C. Waymouth et al. (8), and nearly the same orthorhombic cell dimensions given by them as $a_0=18.25$, $b_0=20.35$ $c_0=7.50$ Å. The fact that Pirsson (6) determined mordenite from Hoodoo Mountain, Wyoming, to be monoclinic encouraged the early belief that the Tintic material was truly arduinite. Some of the Hoodoo Mountain mineral was secured from Dr. Horace Winchell at Yale University and its x-ray powder pattern corresponded nicely to that of heulandite.

Acknowledgments

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Industrial Diamond Development in 1949

As in previous years the Industrial Diamond Information Bureau has compiled a report on the Industrial Diamond Development in 1949. The subject matter is sub-divided into: Scientific Aspects, Instruments Using Diamonds, Metallographic Polishing, Shaped Diamond Tools, Truing Tools, Diamond Dust, Diamond Grinding Wheels, Rock Drilling, Machining of Stone and Similar Materials, Grinding and Polishing of Diamond and Gemstones, Glass Machining, Art, Exhibitions. Copies of this report are available, free of charge, from the Industrial Diamond Information Bureau, 32–34 Holborn Viaduct, London, E.C.1. The mentioned literature can be obtained on loan, or in photostat copies, from the Bureau.