

formulae which can obscure n be placed in the view that AlO_4 tetrahedra is virtually even, is commonly a multiple precise chemical, X-ray and its on the basis of this ideal for a large number of zeolite : Al ratio than to variations se exchange effects and are Nevertheless as the various into their lattices to varying onments of formation must the barium zeolites are not

n of certain zeolites not only ; and (ii) Na_2 for Ca, or more tution: (iii) Al for Si within K , Ca_2) occupying otherwise nber of W group cations per er two types of replacement. ies are listed below together ns listed. Specific gravity is are analcime and wairakite), The values given have been minations and in some cases nees have been cited; many

in molecular proportions on Na_2 , K_2)O being numerically s anorthite. Horizontal lines ough each series. Prehnite, n these the Al_2O_3 content is as been plotted arbitrarily at d structural data. In several analyses of apparently good ighly reactive and unstable e of metastable compositions

with minor substitution of RTWIG, 1928; COOMBS, 1955); analcimes may range from d $Z = 24$ respectively. Y and BANNISTER, 1933). $\text{Al}_{13.5}\text{Si}_{22.5}\text{O}_{72}\cdot 36\text{H}_2\text{O}$. Alkalis O_2 ; $Z = 6$; $D = 2.082$. H_2O ; $Z = 3$. In eight out 5.7 to 16.3 H_2O per unit cell, unit cell, which would make with the approximate range ; D typically 2.25 ± 0.03 .

aturally related to epistilbite.

07 (STAPLES and GARD, 1958). $D = 1.92$ (cf. STRUNZ, 1955).

Gismondine. $\text{CaAl}_2\text{Si}_2\text{O}_8\cdot 4\text{H}_2\text{O}$; $Z = 8$ (KRAUS, 1939) to $\text{Ca}_{0.92}\text{Al}_{1.84}\text{Si}_{2.16}\text{O}_8\cdot 4\text{H}_2\text{O}$ with moderate substitution of $(\text{K}, \text{Na})_2$ for Ca.

Gmelinite. According to STRUNZ (1956), polymorphous with Na-rich chabazite, and often containing chabazite in lamellar intergrowth; $(\text{Na}_2, \text{Ca})\text{Al}_2\text{Si}_4\text{O}_{12}\cdot 6\text{H}_2\text{O}$; $Z = 4$; $D = 2.028$.

Gonnardite. Polymorphous with thomsonite and mostly near $(\text{Ca}, \text{Na}_2)_{4.3}\text{Al}_{8.6}\text{Si}_{11.4}\text{O}_{40}\cdot 12\text{H}_2\text{O}$ (MEIXNER *et al.*, 1956) but can also have higher ratios of Al:Si (MASON, 1957). $D = 2.27 \pm 0.02$.

Heulandite. Normally in the range $(\text{Ca}, \text{Na}_2)_{4.8}\text{Al}_{9.6}\text{Si}_{26.4}\text{O}_{72}\cdot 24\text{H}_2\text{O}$; $D = 2.21 \pm 0.03$; to $(\text{Ca}, \text{Na}_2)_4\text{Al}_8\text{Si}_{28}\text{O}_{72}\cdot 24\text{H}_2\text{O}$; $D = 2.18 \pm 0.03$. There is often appreciable K and/or Sr. In the silica-rich variety clinoptilolite, the composition approaches $\text{Ca}(\text{Na}, \text{K})_4\text{Al}_6\text{Si}_{30}\text{O}_{72}\cdot 24\text{H}_2\text{O}$; $D = 2.14 \pm 0.03$.

Laumontite. $\text{Ca}_{4.25}\text{Al}_{8.5}\text{Si}_{15.5}\text{O}_{48}\cdot 16\text{H}_2\text{O}$ to $\text{Ca}_{3.75}\text{Al}_{7.5}\text{Si}_{16.5}\text{O}_{48}\cdot 16\text{H}_2\text{O}$ with minor replacement of Ca by Na_2 , i.e. near $\text{CaAl}_2\text{Si}_4\text{O}_{12}\cdot 4\text{H}_2\text{O}$; $Z = 4$; $D = 2.29 \pm 0.02$ (COOMBS, 1952). Leonhardite is a partially dehydrated variety with about 14 H_2O .

Levyne. Perhaps $\text{CaAl}_2\text{Si}_4\text{O}_{12}\cdot 5\text{H}_2\text{O}$ to $\text{Ca}_{1.1}\text{Al}_{2.2}\text{Si}_{3.8}\text{O}_{12}\cdot 5\text{H}_2\text{O}$ with moderate replacement of Ca by $(\text{Na}, \text{K})_2$. STRUNZ (1956) suggests polymorphous and structural relationships with chabazite and gives 6 H_2O ; $Z = 9$; $D = 2.140$. The few available analyses appear to indicate 5 H_2O rather than 6 H_2O .

Mesolite. Essentially $\text{Na}_2\text{Ca}_2\text{Al}_6\text{Si}_9\text{O}_{30}\cdot 8\text{H}_2\text{O}$; $Z = 8$; $D = 2.26$; minor Na_2 for Ca (HEY, 1933).

Metascolecite. Higher temperature polymorph of scolecite (HEY, 1936).

Mordenite (ptilolite). $(\text{Na}_2, \text{K}_2, \text{Ca})\text{Al}_2\text{Si}_{10}\text{O}_{34}\cdot 7\text{H}_2\text{O}$; $Z = 8$ (e.g. WYMOUTH *et al.*, 1938). with alkalies usually dominant over Ca. $D = 2.12 \pm 0.03$. First-class analyses (as defined by HEY, 1932a) show variations of no more than 0.15 Al and Si. Synthetic mordenites range from pure Ca to pure Na members (BARKER, 1948 and Appendix 1 of this paper).

Natrolite. $\text{Na}_2\text{Al}_2\text{Si}_3\text{O}_{10}\cdot 2\text{H}_2\text{O}$; $Z = 8$; $D = 2.24$. Up to 1 in 16 Na replaced by K and 1 in 4 Na replaced by Ca_1 (HEY, 1932b).

Phillipsite. $(\text{Ca}, \text{K}_2)_{2.5}\text{Al}_5\text{Si}_{11}\text{O}_{32}\cdot 12\text{H}_2\text{O}$ to $(\text{Ca}, \text{K}_2)_{3.5}\text{Al}_7\text{Si}_9\text{O}_{32}\cdot 12\text{H}_2\text{O}$ with Na usually subordinate (cf. WYART and CHATELAIN, 1938). $D = 2.20 \pm 0.02$ for typical intermediate members of the series.

?*Pseudonatrolite*. Near $(\text{Ca}, \text{Na}_2)\text{Al}_2\text{Si}_6\text{O}_{16}\cdot 5\text{H}_2\text{O}$ (HEY, 1955, p. 162).

Scolecite. $\text{CaAl}_2\text{Si}_3\text{O}_{10}\cdot 3\text{H}_2\text{O}$; $Z = 8$; $D = 2.27 \pm 0.02$. Minor Na_2 for Ca (HEY, 1936).

Stilbite. Approximately $(\text{Ca}, \text{Na}_2)_4\text{Al}_8\text{Si}_{28}\text{O}_{72}\cdot 28\text{H}_2\text{O}$; $D = 2.15 \pm 0.02$; to $(\text{Ca}, \text{Na}_2)_5\text{Al}_{10}\text{Si}_{26}\text{O}_{72}\cdot 28\text{H}_2\text{O}$; $D = 2.18 \pm 0.02$ (cf. SEKANINA and WYART, 1936). The average water per unit cell for some two dozen representative analyses is 28.7 H_2O as against 24.2 for heulandite. The suggestion of STRUNZ and TENNYSON (1956) that a correct formula should show 24 H_2O as in heulandite and that the two minerals are polymorphs as well as having related (though different) structures, is not therefore accepted.

Thomsonite. $(\text{Ca}, \text{Na}_2)_{8.4}\text{Al}_{16.8}\text{Si}_{23.2}\text{O}_{80}\cdot 24\text{H}_2\text{O}$; $D = 2.30$ to $(\text{Ca}, \text{Na}_2)_{10.25}\text{Al}_{20.5}\text{Si}_{19.5}\text{O}_{80}\cdot 24\text{H}_2\text{O}$; $D = 2.38$ (HEY, 1932a). $\text{CaAl}_2\text{Si}_2\text{O}_8\cdot 2.4\text{H}_2\text{O}$; $Z = 10$; $D = 2.37$, is a possible synthetic member (GOLDSMITH, 1952).

Wairakite. $\text{CaAl}_2\text{Si}_4\text{O}_{12}\cdot 2\text{H}_2\text{O}$; $Z = 8$; $Z = 2.265$ (STEINER, 1955; COOMBS, 1955).

Yugawaralite. Unit cell contents calculated from the data of SAKURAI and HAYASHI (1952) are approximately $\text{Ca}_{3.84}(\text{Na}, \text{K})_{0.34}\text{Al}_{7.55}\text{Si}_{21.33}\text{O}_{58}\cdot 15.3\text{H}_2\text{O}$, corresponding roughly to $4\text{CaAl}_2\text{Si}_5\text{O}_{14}\cdot 4\text{H}_2\text{O}$. $D = 2.20$.

APPENDIX 3

Chemical and Physical Data on Heulandite and Prehnite

(A. M. T., D. S. C.)

Chemical analyses and other data on the heulandite and prehnite used in experiments described above are given below.

Heulandite

Locality: Cape Blomidon, Nova Scotia. Colourless crystals.

SiO_2 56.8; Al_2O_3 16.6; Fe_2O_3 tr.; MgO tr.; CaO 5.8; SrO 2.0; Na_2O 1.6; K_2O 0.8;