3.1. *Zeolites in sedimentary rocks*

3.1.1. *U.S.S.R.* Analcime, "mordenite" and laumontite have been reported as authigenic cements in a wide variety of sediments of Permian to Tertiary age coming from vast areas of Russia and Siberia (e.g. RENGARTEN, 1940, 1945, 1950; BOLDYREVA, 1953; DZOTSENIDZE and SKHIRTLADZE, 1953; BUR'YANOVA, 1954, 1956; VASIL'EV, 1954; KOLBIN and PIMBURGSKAYN, 1955; KOSSOVSKAYA and SHUTOV, 1955; VASIL'EV, KOLBIN and KRASNOVA, 1956). According to BUSHINSKY (1950) associated authigenic minerals in Upper Jurassic and Cretaceous clays, sandstones, marls and chalk of the Russian platform include glauconite, opal, chalcedony, quartz, montmorillonite, nontronite, calcite, pyrite or marcasite, hydromica and the phosphates kurskite and francolite.

On the basis of its refractive indices and platy habit as figured by BUSHINSKY and in the absence of X-ray data, the present writers believe that much of the "mordenite" of the above authors is likely to be clinoptilolite, the silica-rich variety of heulandite. VASIL'EV (1954) gives a table of crystallographic measurements of crystals isolated from the phosphorites of Kashpur, and shows that they compare closely with those of DANA (1892) for "mordenite." DANA's crystallographic data were obtained from material from Hoodoo Mts., Wyoming, which was subsequently taken by SCHALLER (1932) as his type clinoptilolite, and shown by HEY and BANNISTER (1934) to be silica-rich heulandite. Crystallographically this is quite distinct from true mordenite.

The Russian authors do not appear to have recognized any zoning in the occurrence of the above zeolites; in fact in two cases (RENGARTEN, 1950; KOLBIN and PIMBURGSKAYN, 1955), analcime and laumontite occur together, whereas in southern New Zealand they are characteristic of, though not confined to, two distinct depth zones. Significant to the concept of mineralogical zoning with depth is the work of KOSSOVSKAYA and SHUTOV (1955) who recognize a progressive sequence of changes in the alteration of clastic biotite to chlorite at varying depths in more than 5000 m of Permian, Jurassic and Cretaceous sediments of the Verkhoyansk geosyncline in north-east Siberia. Laumontite is recorded as occurring as a cement in the Lower Cretaceous members, whereas the cement in the Upper Permian consists of quartz and albite with new-formed limonite and rutile, and in the Lower Permian of quartz and muscovite. Subsequently (1956) the same authors reported authigenic epidote in the same pile of sediments.

3.1.2. *U.S.A.* The work of BRADLEY (1928, 1929), ROSS (1928, 1941) and KELLER (1951, 1952, 1953) on very low temperature sedimentary analcime is well known. HEADY (1952) has detected the mineral in a Colorado oil shale while FOSTER and FEICHT (1946) and ROZENDAL (1957) have found it in coal. Similarly BRAMLETTE and POSNJACK (1933) and KERR and CAMERON (1936) have demonstrated the common occurrence of clinoptilolitic heulandite partly preserving glass shards in bentonites, while GILBERT and MCANDREWS (1948) have described authigenic heulandite cement in Miocene sandstone from Santa Cruz Co., California.

Laumontite cements have been reported by GILBERT (1951) from Mendocino Co., California, by KALEY and HANSON (1955) from Miocene feldspathic sandstone at a depth of 11,000 ft in a well in San Joaquin Valley, California, and by HEALD