Heulandite exists over a wide range of silica content (Appendix 2) and high-silica heulandite (1a in Fig. 3) could theoretically be dehydrated into high-alumina heulandite (1b), thus:

$$\underset{\text{clinoptilolite (1a)}}{5(Ca, Na_2)_3Al_6Si_{30}O_{72}.24H_2O} \rightarrow \underset{\text{heulandite (1b)}}{3(Ca, Na_2)_5Al_{10}Si_{26}O_{72}.24H_2O} + \underset{\text{quartz}}{72\,SiO_2} + \underset{\text{water}}{48\,H_2O}$$

This reaction is complicated by the fact that clinoptilolite tends to be richer in alkalis than typical heulandite and the chemical nature of the parent ash may well provide the main control over the composition of the phase found. Stilbite is chemically equivalent to a normal or high-alumina heulandite plus additional water. Its position as a low-temperature, post-orogenic joint-filling is therefore not incompatible with the suggestion that temperature exercises a major control over zeolite occurrence in the Taringatura area.

2.2.2 *Hokonui Hills and south-east Otago.* Equivalents of the Triassic beds of the Taringatura Hills, as well as overlying Jurassic formations, outcrop almost continuously for 100 miles to the south-east, where they reach the sea. Scattered observations indicate similar alteration phenomena to those described above, but it may be noted that laumontite replaces plagioclase in certain Jurassic beds of the Hokonui Hills (COOMBS, 1952, p. 813) that can hardly have been buried as deeply as the vaguely defined laumontite zone of Taringatura.

In about 4000 ft of the lower Middle Triassic siltstones exposed on the coast near Kaka Point, over 300 thin, water-laid ash beds have been altered to bentonite containing heulanditized (clinoptilolitic) glass relicts, to aggregates of heulandite, microcrystalline quartz and clay minerals, or to analcime and quartz sometimes partially replaced by albite. Celadonite is often present. Detrital calciferous plagioclase and ferromagnesians are largely unaltered both in the tuffs and in the associated siltstones in which occasional glass shards are heulanditized. This part of the section is thus dominantly in the heulandite–analcime stage of alteration as defined for Taringatura.

At Nugget Point, several miles to the south-east, Kaihikuan (Middle Triassic) ash is in part heulanditized or bentonitic but is mostly altered to laumontite in beds which are locally metasomatized to albite rock. Plagioclase in the tuffs and associated volcanic greywackes and arenites is often albitized, but relict andesine is sometimes found. Laumontite occurs in minor crush zones. This part of the section is dominantly in the laumontite stage of alteration, but its structural relation to the area of less altered Lower Triassic beds to the north of it is not yet fully elucidated.

SPEDEN (1956) has described both zeolitic and quartz–albite–prehnite assemblages from Jurassic beds in the Catlins district still further to the south. A significant phenomenon noted by SPEDEN is the direct replacement of calciferous plagioclase by heulandite or analcime, indicating that in the analcime–heulandite stage these zeolites are stable relative to plagioclase plus water, even though this alteration seldom proceeds far, presumably due to slow reaction rates or lack of sufficient water at the grain boundaries. The Catlins section described by SPEDEN, 11,700 ft thick, is dominantly in the laumontite stage, although anomalously it is in one of the upper formations that both the prehnite and heulandite–analcime assemblages were observed.

2.2.3. *Nelson and south-west Auckland.* Andesitic volcanic greywackes, tuffs and siltstones of the *Mytilus* beds (Otamitan stage, Carnian) at Wairoa Gorge, Nelson (O.U. 15822–15827) show heulandite–analcime stage alteration, much as described for Taringatura, apart from the abundance of calcite accompanying one or other of these zeolites in the matrix. Near Marakopa in south-west Auckland (O.U. 11426 *et seq.*), Middle to Upper Triassic beds (CAMPBELL, 1955) form the lower 11,000 ft of the west limb of a Triassic and Jurassic synclinal section