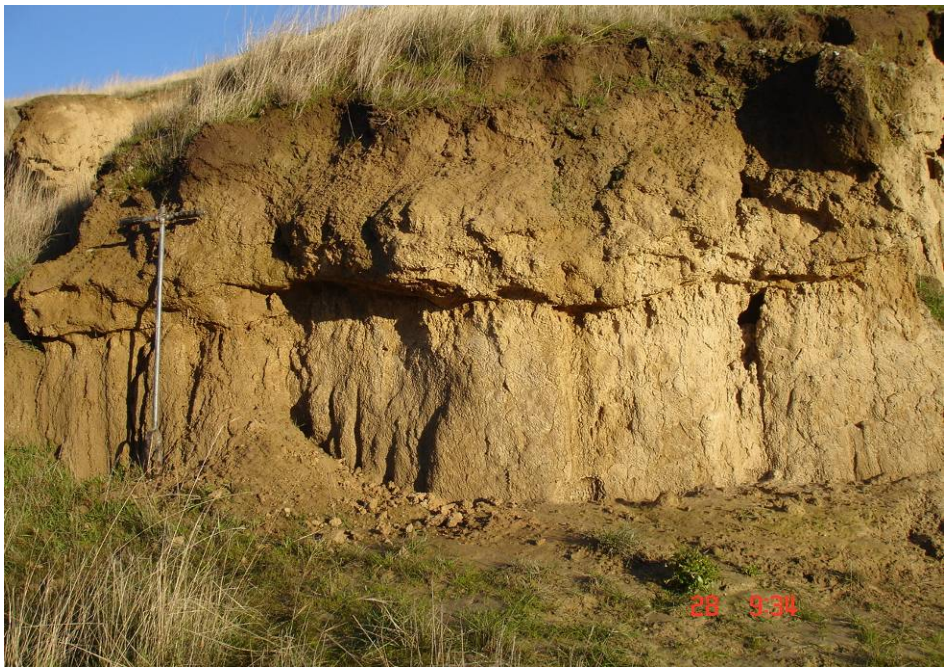

Figure 36. At this site, water in the saturated soil was flowing down-slope on the top of the pan and trickling down the face of the section, causing dispersion of the clay loam material beneath and undercutting the pan. The dispersed soil is being deposited as structureless caked material at the front of the section as headward erosion continues.

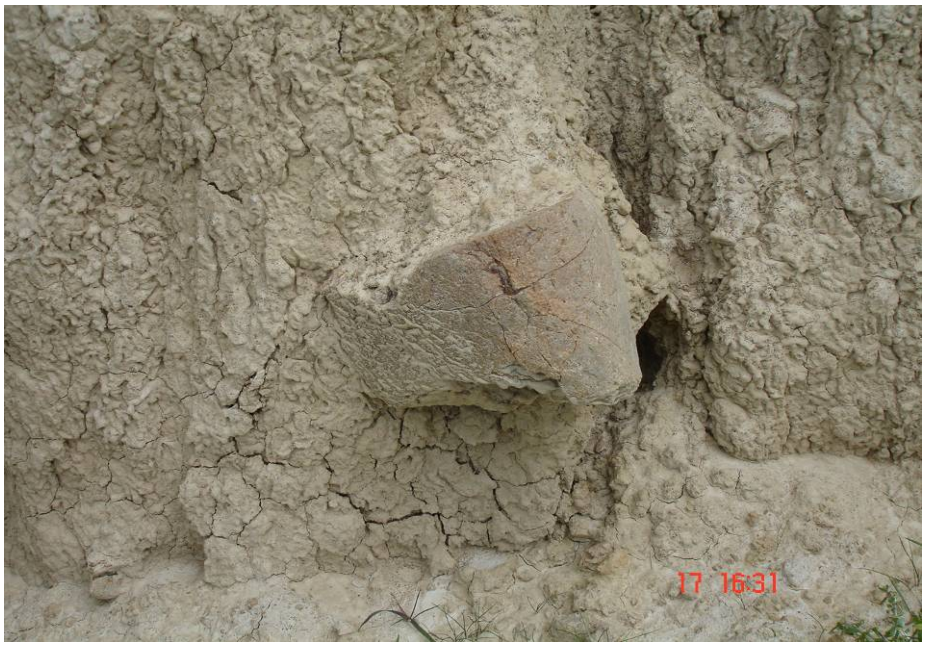

Figure 37. A small solitary boulder within the dispersible silty clay soil material below the fragic horizon. The orientation of the long axis down slope suggests that it has slid rather than being transported amongst a mass of other material, which suggests that solifluction (sliding of thawed material on a firm or frozen surface) may have been the mechanism of transport. The fracturing in the clast has come later as part of soil weathering and may have been facilitated by high salt concentrations present in the soil during the earlier cold and dry conditions.

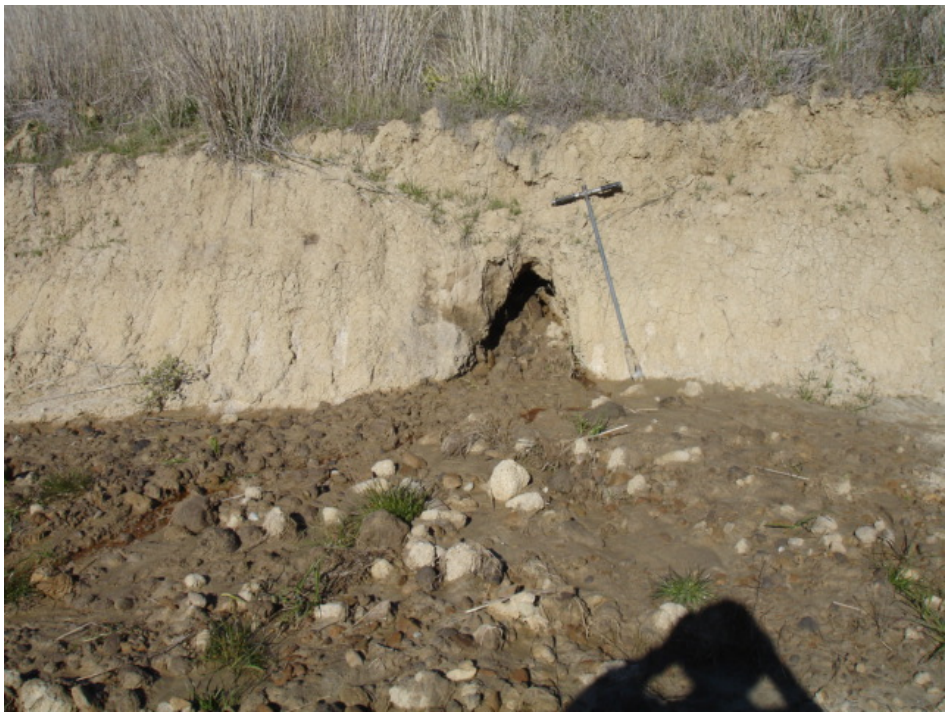

Figure 38. A piping channel on a lower slope with outflow water-transported debris (colluvium) deposited during heavy winter rains.

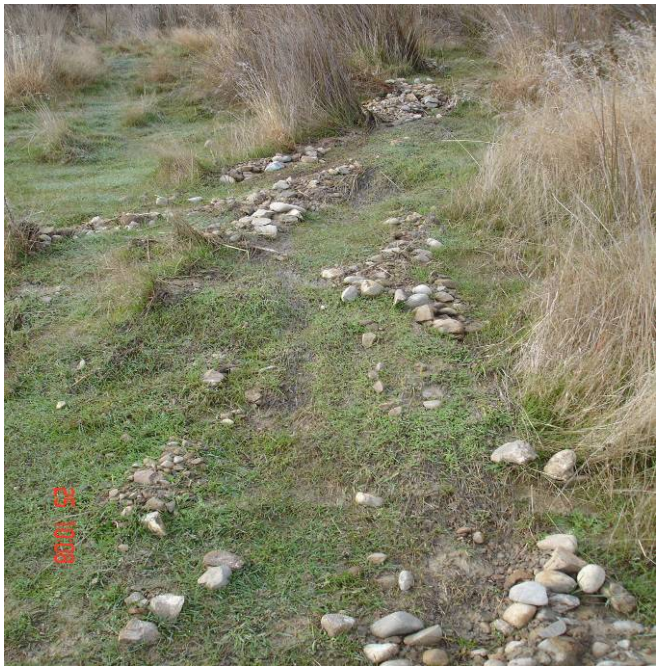

Figure 39. Recently deposited coarse material (colluvium) deposited mid slope, and transported by water from a small up-slope outlet pipe.

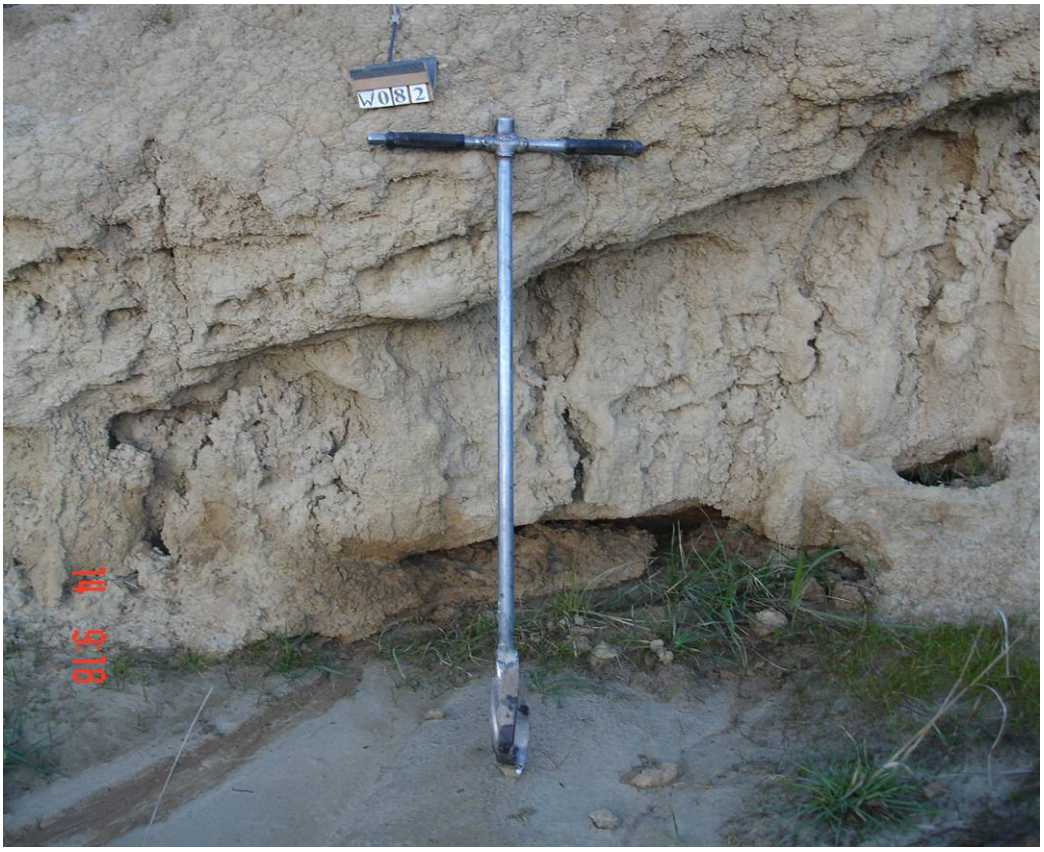

Figure 40. Silt deposited at a piping outlet as a result of soil dispersion. The fragic horizon has multiple layers.

7.6. Vernon Soils

Vernon soil was first named by Laffan (1973) and Laffan and Cutler (1977) when they were separated from Wither soils (formed from thick loess and loess colluvium) as the soils formed from mixed loess and gravel colluvium (previously Wither shallow silt loam hill soils Gibbs and Beggs 1953). They were noted to occur in down-slope positions where mixing of loess with gravels had occurred and with increasing stoniness, they graded into Waihopai soils and with decreased stoniness into Wither soils.

Vernon soils were mapped over approximately 30% of the surveyed area. They occur over a range of slopes from strongly rolling through to steep and more especially on the lower surfaces of the valleys and gullies, as well as on gully and valley head surfaces (Figs. 41-43). Vernon soils are transitional grading into Waihopai soils, often within a few metres, where loess becomes thinner (Fig. 15) and into Wither soils where loess increases in thickness and the stone content becomes negligible.

Vernon soils (Figs. 44-47) resemble Wither soils with topsoils that are brown to dark brown, and generally less than 10 cm thick, although a topsoil is often absent due to sheet erosion. The B horizon is generally yellowish brown silt loam to clay loam, often becoming mottled in the lower part. A Bx horizon or pan was noted only in about 20% of the observations with the underlying soil material commonly passing into firm clay loam with stones or boulders. In places, salts are present as precipitates on exposed vertical profile sections. On lower slopes, the deposits may be deep with numerous boulders (Fig. 44).

Unlike Wither soils, the horizon sequences are quite variable and the thick clayey to silty gravelly layers that underlie the Wither soils are seldom seen. The common feature of Vernon soils is the presence of stones through the upper layers and in varying amounts. The deposits from which Vernon soils have formed are generally thinner on upper slopes and thicker on the lower slopes. The

heterogeneous character of the Vernon soil material with a somewhat random distribution of the stones that are present suggests that at the time of deposition, conditions may have been the same as when Wither soils were formed, but with a greater degree of down-slope movement of materials taking place.

7.7. Erosion and Stability in Vernon Soils

Vernon soils, like Wither soils exhibit a high degree of instability with tunnel gully erosion being the main form, although sheet erosion is also prominent in places (Figs. 47-52). Vernon soils however mostly lack the thick underlying silty gravel layers of Wither soils, hence deep gullying seldom occurs and most gullies are between one and two metres in depth. Many of the gullies that were observed had piping channels at the base indicating that downslope movement of deeper materials is still active. The upper horizons of Vernon soils in places appear to be susceptible to sheet erosion (Figs 50-55). The same erosion processes are present in Vernon soils as in Wither soils, namely the slaking and disaggregation of dispersible soil horizons followed by piping and roof collapse of tunnels. Sheet erosion is a prominent part of the soil instability in Vernon soils with the topsoil and upper subsoil commonly being removed and caked surfaces forming on both the eroded surfaces and on sites downslope where sediment has been deposited.

During the 1970's, extensive erosion control and soil remediation work was carried out by the Marlborough Catchment Board in the Wither Hills. This involved chisel contour ploughing and reforming the land surface by bulldozing to a sufficient depth to infill the gullies with uneroded soil and form a new, relatively uniform ground surface. In numerous places, upper surfaces of the valley sides were treated in an effort to prevent or minimise the infiltration and concentration of water into the subsurface and thereby reduce gullying on slopes below (Figs 53-55). The result of this was that there was considerable mixing of soil materials including burial of topsoils (Figs. 56 & 57). Where soil was removed to fill in the gullies, subsoil material, some of it dispersible, was exposed and formed part of the new soil surface (Fig. 58). Detrimental effects of this work were a loss of soil structure, reduced soil permeability, increased surface runoff, the formation of surface crusts, difficulty of establishing a satisfactory new vegetative cover and continued tunnel gullying,

It is not clear to what extent Wither soils, with their deeper gullies, were treated in this way or whether most of the remedial treatment was on Vernon soils, which would have been more amenable to treatment because of their shallower gully system. Areas that were previously Wither soils and which were treated can now be regarded as akin to Vernon soils, as the mixed soil material without a hard pan now resembles Vernon rather than Wither soils. In many places the re-formed ground surfaces are distinguished by the presence of scattered surface stones, often boulder sized, which emphasise the ongoing loss of surface soil by sheet erosion. This soil remediation work has only been partially successful as in many places, new gullies have formed and sink holes point to the presence of active under-runners. Extensive surface caking with poor vegetative cover is also associated with many of these "remediated" sites.

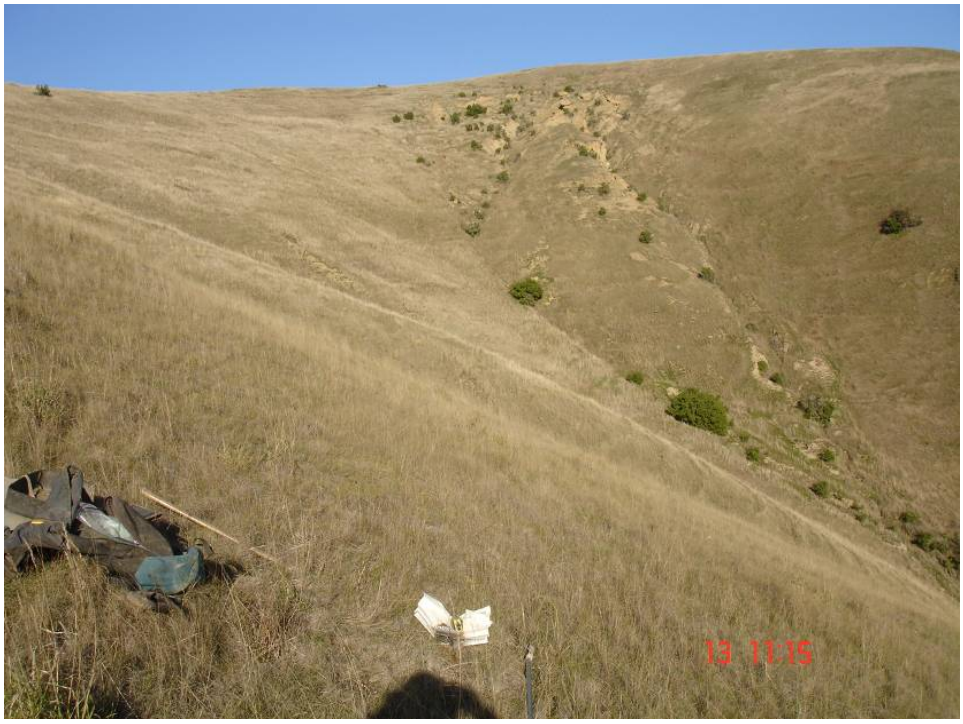

Figure 41. Vernon hill soils with shallow gully erosion occupying a typical gully head position. Waihopai hill and steepland soils are on adjacent surfaces.

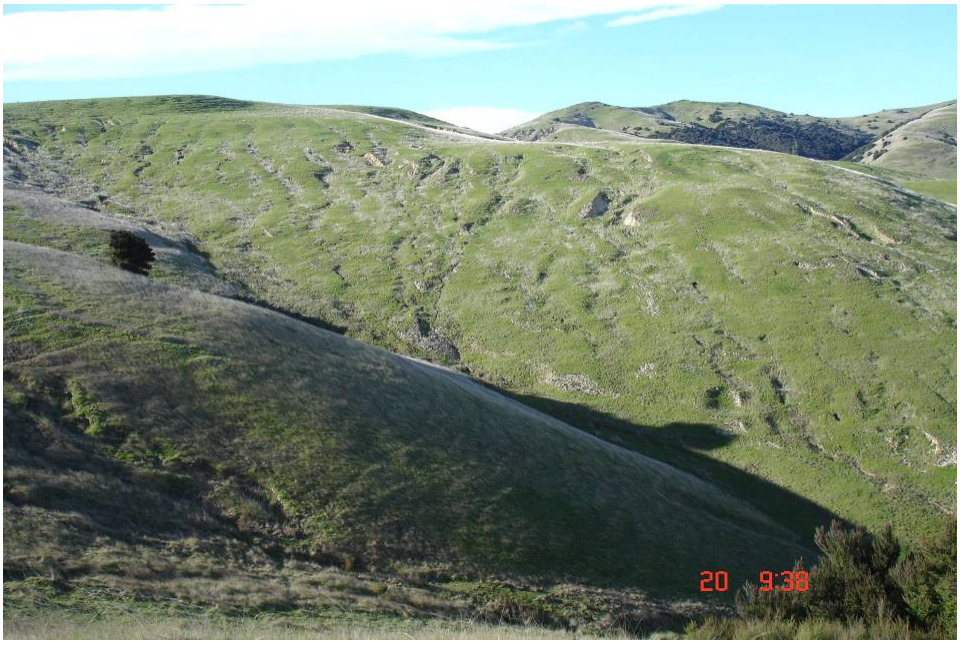

Figure 42. Vernon/Wither soils with shallow gully erosion on the hill slopes below a ridge crest. Waihopai hill soils are on the spur and ridge slopes in the foreground.

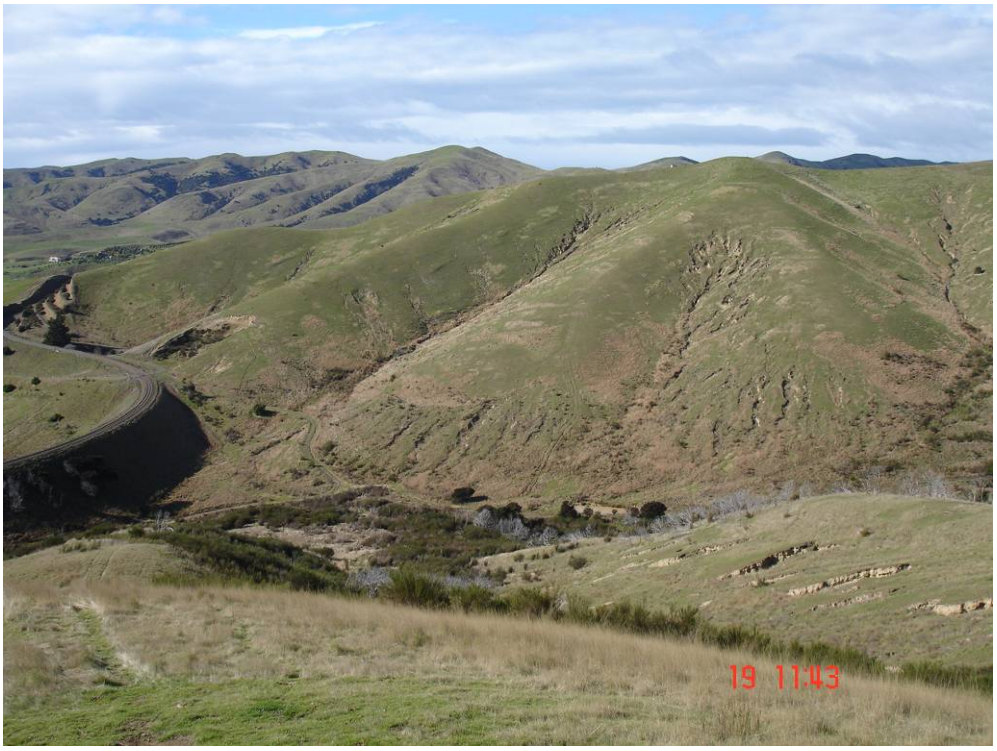

Figure 43. Vernon hill soils are on the lower slopes on the opposite side of the valley (marked by the shallow gullying) where loess and coarse materials have accumulated and Waihopai hill soils are on the spur crests. Wither hill soils are on the slopes on the right foreground and Waihopai hill soils on the immediate foreground slopes.