humid, is quite fresh, perceptible currents of air are at all times existing in the more contracted passages, and during our last visit, when a strong breeze was blowing outside, the draughts in these places were so strong that candles could not be used without shelter. This was especially observable in the contracted parts of the north-western cave and branch, in which the current was flowing *inwards*, in both cases, but in directions *diametrically-opposite;* while in the branch of the southern pair, the current was *outwards*, but only near its outer extremity, being evidently fed by the other branch, which slightly overlaps it about forty feet from its entrance. No visible communication however was observed. The positions and directions of those strong air-currents are marked on the plan by arrows.

Regarding the origin of these caves, it seems quite evident that the molten lava has found some outlet after the surface has solidified. Some very interesting traces of this process are visible, especially in the two branches. The floors are covered with curved corrugations, expressive of solidifying while in a state of slow motion, and in some cases the walls seem to have settled down a little, and squeezed the semi-plastic floor into long ridges and furrows. It seems probable that the whole group was formed from one molten stream, and not at different times from different levels. The upper caves, most likely, were formed first, and, after the floor had become firm, the still-fluid lava below seems to have found some passage downwards, somewhere near the abrupt descent or precipice in the main cave, thus forming the branch. On the face of this precipice, evidence can be traced of the descent of a portion of lava while in an almost solid state. Indeed, at this particular place, everything points to the probability of the lava having found its way into the hollows of some older lava stream. The occurrence of regular chambers, and minor branches, may be explained in the same manner, as the hotter and more fluid lava, collecting in pools, would be tapped and drained away. The roof, where in its original state, is also very suggestive of the above theory. It has all the appearance of some plastic material *pulled* asunder, having solidified in irregular guttæ.

The percolation of water has, in some places, precipitated, on the surface of the roof, a mineral, generally white, but having, in several places, a red or green tinge. I am not aware of the nature of this mineral, but it is probable that lime, which enters in small quantities into the composition of our scoria, is the chief ingredient.

Such is a brief and imperfect description of an interesting part of the Auckland scoria beds. The survey was attended with many difficulties, owing to the general roughness, and contracted dimensions of some of the passages, and the use of the level and staff in these, was anything but easy. On these grounds it is hoped that all imperfections will be excused.

Art. XXXIX.—*On the Wanganui Beds (Upper Tertiary).* By J. Buchanan, of the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, September* 18, 1869.]

The following notes give the results of a comparison of the fossil shells from the Upper Tertiary stata of New Zealand, which are in the Colonial Museum, with the fossils obtained by the author, in that portion of the formation locally known as the "Wanganui series":—

Wanganui Beds (Upper Tertiary).

The information, respecting the latter series, is founded on personal examination of the cliffs of the Wanganui river, near the township, and

continued six miles on No. 2 road-line, in the direction of Wangaehu, and six miles on No. 3 road-line, up the river; also, as far north as Patea for forty miles along the sea coast, at various points between the Kai Iwi and Waitotara rivers, and between the Whenuakura and Patea rivers.

Over the area thus surveyed, the beds are uniformly the same, so that it is unnecessary to protract a section of each particular locality.

In some places they are slightly disturbed—as for instance opposite the town of Wanganui—but, on the whole, they strike in North and South line, with a dip of 10° to 15° to the East; the blue clay stratum which I shall describe, keeping, in general, parallel with the drainage level of the country.

The formation consists of an upper sandy, and lower clay stratum, and separated by a deposit of sand of varying thickness, being at least twelve feet in Shakespere cliff, at Wanganui, the whole covered by a heavy deposit of sands and gravels, containing a cemented gravel bed also of variable thickness, the material from which is in common use for the construction of roads throughout the district.

Along the sea coast the blue clay rises to a height of from one to forty feet above the sea level. A few shells appear to be confined to this deposit, such as Murex* No. 2, Pecten No. 2, and Mytilus No. 2. A few others decrease upwards in the series such as Ancillaria, Murex No. 1, Fusus No. 2, Pecten No. 1, and Ostrea No. 2. Again, a few shells, poorly represented in the blue clay, become very numerous in the upper bed, such as Lucina No. 2, Rotella, Waldheimia, and *Imperator imperialis.*

The upper bed of the series has generally an open sandy matrix, varying in thickness from four feet at Shakespere cliff, to over a hundred feet at the lower cliffs below Putiki pa; the blue clay, or lower bed, scarcely showing there above the river level.

In this upper bed the following species occur for the first time, in addition to those mentioned as common to both formations:

Ostrea ingens,	*Cardium* No. 2,	Tapes,
Ostrea No. 3,	*Pecten* No. 7,	Tellina,
Pectunculus No. 1,	Mactra No. 1,	*Pileopsis,*
Pectunculus No. 3,	Mactra No. 2,	Triton,
Pecten No. 3,	Donax,	Myadora.

(Extinct forms are in italics.)

There is every probability that, in addition to the above two beds, an older stratum exists, more inland, characterized by the presence of Cucullæa, and if the blue clay of the Patea river should prove to belong to this lower bed, the proportion of extinct species in the Wanganui beds would be considerably diminished.

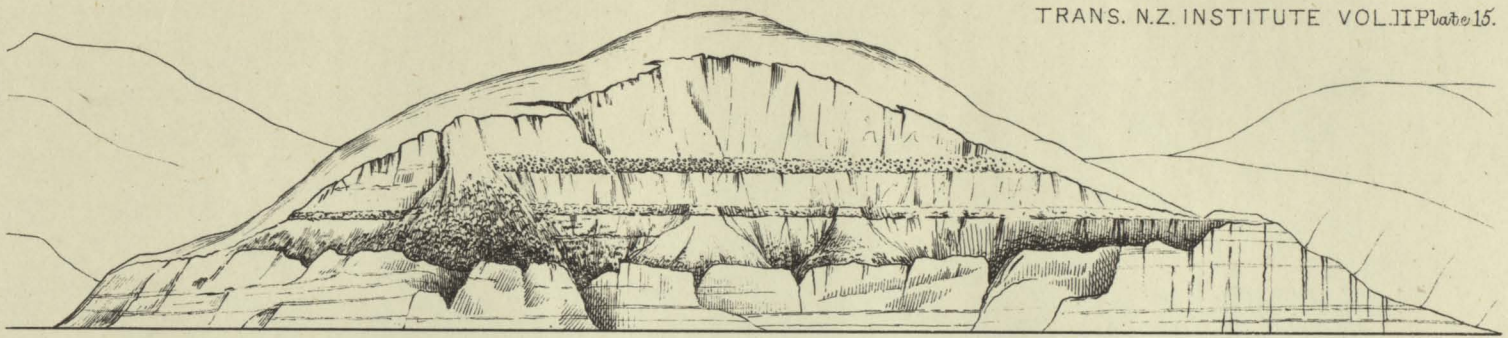
Napier Beds (Upper Tertiary).

The fossils collected at Napier are too few to determine the relative position of the Limestone formation there; but there is no doubt that several of them are identical with those of the Upper Wanganui beds, and probably belong to the same period.

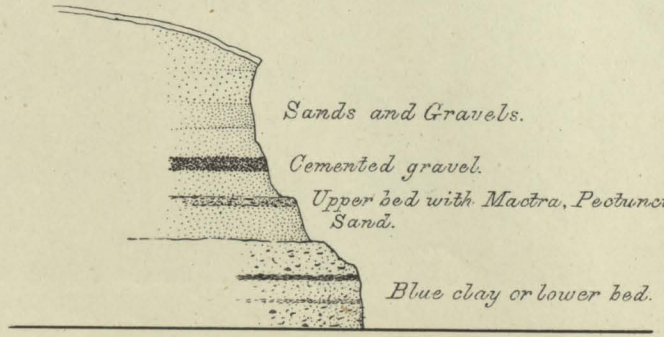
Blue Clay-marl. Kanierei River, Westland.

Of the fifteen species collected at Hokitiki, every one of them are common at Wanganui, so that it may be inferred that they belong to the same period.

* Instead of attempting to give scientific names, the numbers by which each specimen is distinguished in the Museum, is employed.—Ed.



SHAKESPERE CLIFF WANGANUI.



Section of Shakespere Cliff.

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WANGANUI &c.

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Kawau Island Beds.

The Kawau Island deposits contain only extinct species, and have been erroneously grouped with the newer-tertiary formation, by Hochstetter, from the species having been mixed with more modern forms from a littoral deposit at Cape Rodney.

A list of the Cape Rodney shells is given separately; all of them being extinct species.

Awatere and Motanau Beds (Upper Tertiary).

The Awatere and Motanau clays are undoubtedly of the same age, and it is very probable, when further examined over the whole area, will be naturally grouped in three subdivisions. At Motanau three beds can be distinctly recognized: first, an upper sandy bed, containing the most common shells of the adjacent coasts; second, a middle blue clay bed, containing probably fifty species, nine-tenths of which are identical with those of the blue clay at Wanganui; these upper and middle beds lie conformable, and have, evidently, like those at Wanganui, been accumulated on their breeding grounds, on quiet sea bottoms. Not so the third, or lower, blue clay bed, found inland near its outcrop. It exhibits masses of concreted broken shells, the result of wave action on an ancient sea beach. The proportion of extinct species in this series is very small, and those chiefly miocene fossils, of the lower bed, such as Cucullæa.

SUMMARY.

By a comparision of the fossils collected in the different districts, with those of Wanganui taken as a standard—as being the most complete—the evidence is conclusive of the sameness of the whole, with the exception of the Kawau beds, as a reference to the columns will show.

The formation must be divided into three groups: an upper, a middle, and a lower; nearly every genus of the upper and middle beds still existing on the adjacent coasts.

Napier.

Ostrea—2 sp., Mytilus, Pecten—3 sp., Crepidula, Calyptræa, Venus, Pectunculus. Total, 10 sp.: recent 7, extinct 3.

Cape Rodney.

Haliotis, Cardium, Scalaria, Fusus—2 sp., Turritella, Teredo, Pectunculus, Pecten—2 sp., Rhynchonella, Turbo, Ostrea. Total, 14 sp.: recent 13, extinct 1.

Kawau.

Ostrea, Turritella, Turbo, Crassitella, Natica, Pectunculus. Total, 6 sp., all extinct.

Hokitika.

Fusus—2 sp., Dentalium, Voluta—2 sp., Natica, Limopsis, Trophon, Turritella, Leda, Pecten, Ancillaria, Cassis, Venus, Pectunculus. Total, 15 sp.: recent 13, extinct 2.

Waipara.

Fusus—2 sp., Natica, Turritella—2 sp., Scalaria—2 sp., Struthiolaria—2 sp., Crepidula—2 sp., Calyptræa, Voluta, Cucullæa—4 sp., Dentalium, Echinite—3 sp., Trochus, Shark's tooth, Crania, Pectunculus—2 sp., Waldheimia—4 sp., Ostrea, Venericardia, Myodora, Pecten—5 sp., Venus—2 sp., Mactra, Mytilus, Modiola, Lucina, Panopæa, Cytherea, Artemis, Lima. Total, 48 sp.: recent 27, extinct 21.

AWATERE.

Fusus—3 sp., Voluta—2 sp., Natica, Turritella—3 sp., Struthiolaria—6 sp., Crepidula—3 sp., Calyptræa, Trochita, Ancillaria, Balanus, Pectunculus, Ostrea—2 sp., Pinna, Mactra, Lutraria, Artemis, Tapes, Tellina, Cucullæa, Dentalium, Purpura. Total, 34 sp.: recent 26, extinct 8.

MOTANAU.

Fusus, Voluta—2 sp., Natica—2 sp., Struthiolaria—3 sp., Turritella, Crepidula, Venericardia, Pecten, Ostrea, Terebratula, Cardium, Pectunculus, Mactra, Dosinia, Artemis, Tapes, Venus—4 sp., Sanguinolaria, Lutraria, Cucullæa—2 sp., Dentalium—2 sp., Tellina, Mytilus, Trochus, Nerita, Balanus, Rotella, Imperator, Pholas, Saxicava, Pinna, Modiola, Struthiolaria. Total, 42 sp.: recent 34, extinct, 8.

WANGANUI.

Murex—3 sp., Fusus—6 sp., Trichotropis, Trophon, Mangelia, Triton, Buccinum—4 sp., Purpura, Lymnæa, Ancillaria, Cassis, Trochus—2 sp., Imperator, Rotella, Pleurotoma, Auricula, Cerithium, Turritella—3 sp., Scalaria, Mytilus—2 sp., Ostrea—3 sp., Pinna, Modiola—2 sp., Venus—8 sp., Dosinia, Terebratula, Terebratella, Waldheimia—3 sp., Rhynchonella, Cardita, Tapes, Artemis, Lucina—2 sp., Cardium—3 sp., Venericardia, Natica—3 sp., Voluta—2 sp., Struthiolaria—3 sp., Pileopsis, Crepidula—3 sp., Calyptræa, Trochita, Emarginula, Hemitoma, Lima—2 sp., Balanus, Echinus, Echinarachnius, Turbinolia, Vermetus, Teredo, Coral—2 sp., Bryozoa (?), Pecten—7 sp., Mactra—3 sp., Arca, Chamostrea, Nucula, Corbula, Tellina—2 sp., Lutraria, Panopæa, Mya, Pectunculus—4 sp., Mesodesma—3 sp., Donax, Psammobia, Sanguinolaria, Myodora. Total, 121 sp.: recent 109, extinct 12.

Grand Total, 290 sp.: recent 229, extinct 61.

ART. XL.—*On the Tertiary Series of Oamaru and Moeraki.** By CHARLES TRAILL.

[*Extract from a letter to Dr. Hector, May* 25, 1869;—*read before the Wellington Philosophical Society, September* 18, 1869,]

I BEG to communicate some observations concerning a formation which, in this district, rather puzzles me. I call it the "Blue clay" formation for want of a better name, that being the usual term for the principal deposit of it that I have seen. Very near Hampden, a well, sunk by Mr. Gleeson, for, I believe, 300 feet, did not penetrate through it; but it is often yellow or yellowish-brown, and not unfrequently forms hard rock, as you are doubtless aware. I myself have not noticed it north of the lower Waitaki, south of the Moeraki boulders, or west of Mr. Feren's station on the Kakanui, but have seen specimens of it from other parts of Otago and Canterbury. You probably know whether the Awatere blue clay contains similar fossil remains or not.

Some time since I was endeavouring to work up the fossil shells of this formation, with the view of determining approximately the proportion that has become extinct.

Of course, in a collection of fossils, we must expect a number on which we cannot pronounce with certainty, by reason of their imperfect condition, as I need hardly say; but I have been at pains to procure and lay bare, at least one good specimen of each species, so as to reduce the doubtful cases to a comparatively small number. Striking these off until further light is thrown on them, and reckoning, on the one hand, those between which and the recent I am unable to distinguish any difference; and on the other hand, those which

* See *Mantell*, "Quart. Journ. Geol. Soc.," Vol. vi., p. 333.—ED.