PF: 103I 224 Zymoetz River

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Stratigraphy, deformation and low grade metamorphism of the Telkwa Formation near Terrace, British Columbia

Project 800028

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Abstract

Volcaniclastic rocks of the Telkwa Formation (of the Hazelton Group) form the western margin of the Intermontane Belt near Terrace, B.C., and are cut by intrusions of the Coast Plutonic Complex. These rocks outcrop for 25 km in the dip direction of a moderately eastward dipping homoclinal succession.

Development of a gross volcanic stratigraphy within the map area is based on the recognition of (a) mineralogical and compositional trends and (b) rare, but distinctive and widespread tephras. Hydrothermal metamorphism to zeolite and prehnite-pumpellyite facies is stratigraphically controlled, and depends upon both bulk rock composition and depth of burial. Zeolite facies metamorphism predominates in the upper felsic portions of the stratigraphy, while prehnite-pumpellyite-epidote is found in the generally more basic rocks of the lower half of the sequence.

Westward-directed imbricate thrusts in the west, and rotated block faults in the centre and east of the map area resulted in the repetition of the observed stratigraphy. The undisturbed Telkwa section may have been as thick as 6 or 7 km.

Résumé

Les roches volcanoclastiques de la formation de Telkwa (du groupe de Hazelton) forment la limite ouest de la zone Intermontane, près de Terrace (C.-B), et sont coupées par des intrusions du Complexe plutonique côtier. Ces roches affleurent sur une longueur de 25 km dans la direction du pendage d'une succession homoclinale dont la pente s'incline légèrement vers l'est.

Le développement d'une stratigraphie volcanique grossière à l'intérieur de la région cartographiée est basé sur la reconnaissance, a) de tendances minéralogiques et de compositions, et, b) de projections volcaniques (tephra) rares mais distinctes et répandues. La stratigraphie contrôle le degré de métamorphisme hydrothermique, du faciès à zéolites à celui à prehnite et à pumpellyite, et dépend à la fois de la composition de la roche en vrac et de la profondeur de son enfouissement. Le métamorphisme du faciès à zéolites prédomine dans les parties supérieures felsiques de la stratigraphie, tandis qu'un faciès à prehnite et à pumpellyite avec épidote se trouve dans les roches généralement plus basiques de la partie inférieure de cette séquence.

À l'ouest, des poussées imbriquées orientées vers l'ouest, et des blocs faillés pivotés dans le centre et l'est de la région cartographiée, ont entraîné une répétition de la stratigraphie observée. La section non perturbée de Telkwa avait probablement une épaisseur de 6 à 7 km.

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Introduction

Recent remapping of the Terrace (NTS 103I east half) map area by Woodsworth et al. (1985) has produced a stratigraphic subdivision of the Mesozoic rocks consistent with that in common use in west-central B.C. (Tipper and Richards, 1976). The stratigraphy is dominated by the Upper Triassic to Middle Jurassic Hazelton Group, a thick volcanic sequence. In Terrace map area, the Hazelton Group is itself dominated by the Howson subaerial facies (Tipper and Richards, 1976) of the Telkwa Formation. These rocks are mainly subaerial volcanics with thick (20-200 m) epiclastic sequences.

This preliminary description of the Telkwa Formation in the Terrace area is based on fieldwork done in 1984 and 1985, mainly on a well exposed section south of the Copper (Zymoetz) River west of the Clore River (Fig. 76.1 and 76.2) on NTS maps 103I/8 and 93L/5. Equivalent rocks have been studied in detail near Smithers (Dudley, 1983; Tipper and Richards, 1976) where thickness estimates of 2-2.5 km have been made. Within the study area, however, the Telkwa Formation and related volcanics attain a thickness of 6 km. These rocks outcrop as a moderately dipping homoclinal succession for 25 km in their dip direction.

Stratigraphy

The oldest rocks observed within the area are Paleozoic (mainly or entirely Lower Permian) carbonates and underlying cherts and volcaniclastics(?). These are unconformably overlain by Upper Triassic (?) and Lower Jurassic volcanics of the Telkwa Formation (Woodsworth et al., 1985). The Telkwa Formation has been subdivided into four members primarily on the basis of textural, mineralogical, and depositional facies differences.

<u>Paleozoic "basement" rocks</u>

The Mesozoic volcaniclastic rocks rest unconformably atop, or are juxtaposed with, Paleozoic volcanic and sedimentary strata.

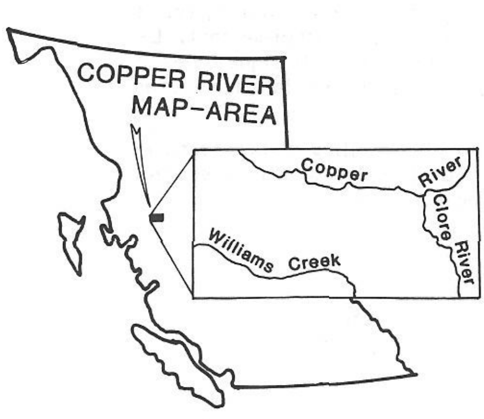
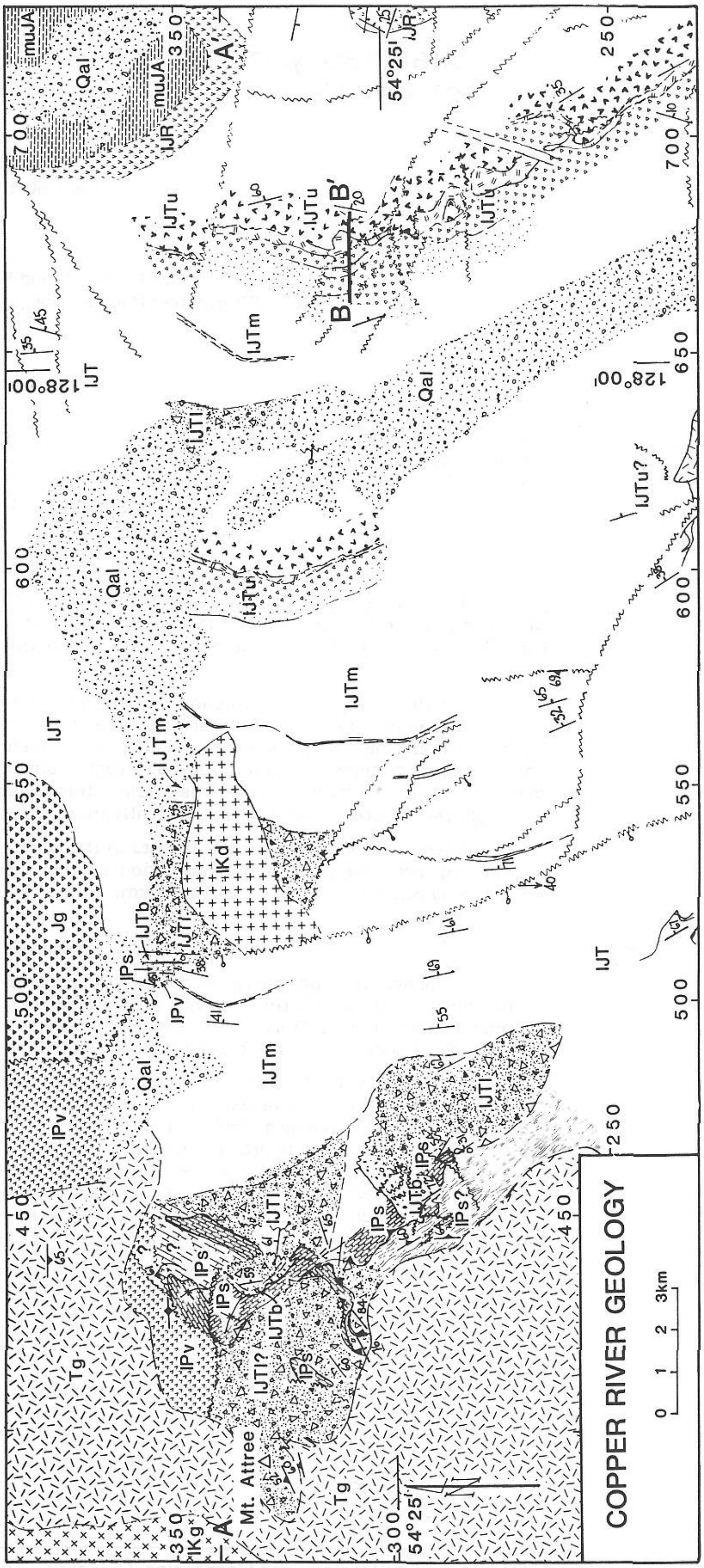
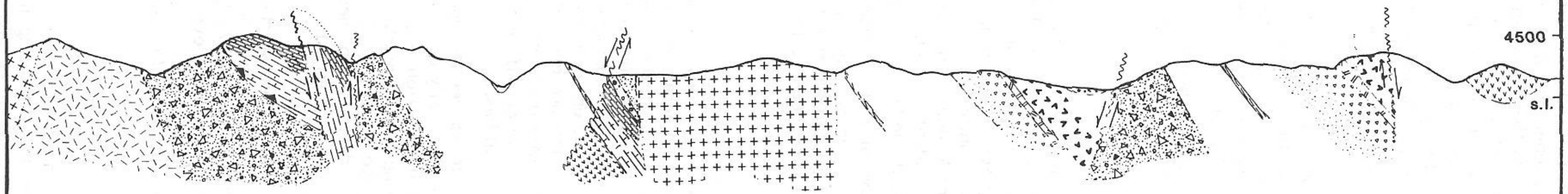


Figure 76.1. Location map. The area indicated by the rectangle is shown in Figure 76.2.



COPPER RIVER CROSS SECTION A – A'



LEGEND

- Qal — Quaternary alluvium
- Tg — Post-tectonic granite, granodiorite
- LKg — Pre- to synkinematic granodiorite, tonalite
- lKd — Pre- to syn-kinematic granodiorite, tonalite –altered
- Jg — Granodiorite to granite displaying brittle deformation, unfoliated
- muJA — Ashman Fm. siltstones to conglomerates
- lJR — Red Tuff Member (NIlkitkwa Fm.) Well bedded lithic ash tuffs
- lJT — Telkwa Fm. (Howson Subaerial Facies) Undivided basaltic to rhyolitic tuffs, breccias and flows. Minor sediments
- lJTu — Telkwa Fm. upper member. Distinguished by a sequence from bottom to top of bedded gravels to siltstones: red. zeolitized lithic lapilli and ash tuffs: a quartz-bearing lithic tuff: a partly welded feldspar crystal. lapilli ash tuff (grey dacite): zeolitized red. lithic ash tuffs: finely banded vitric ash tuff.
- lJTm — Telkwa Fm. middle member. Variegated breccias, tuffs and flows. Conglomerates and volcanic sandstones are not rare. Flows of bladed feldspar porphyry are widespread. A mauve ignimbrite unit is conspicuous.
- lJTl — Telkwa Fm. lower member. Pyroxene (and minor hornblende) breccias and subordinate tuffs and flows.
- lJTb — Telkwa Fm. basal member. Limestone boulder conglomerate grading upwards into cross bedded lithic gravels and sands.
- lPs — Fossiliferous limestone (or marble) with gradations to micrites and silty limestones. Rare tuff interbeds, cherts
- lPs? — Foliated cherts, argillites and volcaniclastics?
- lPv — Poorly defined green, cherty volcanics, breccia and tuffs. Including related metamorphic rocks.

Contact – observed, inferred

Fault – observed, inferred

Thrust – observed, inferred

20 13 40 Bedding, foliation, lineation

Figure 76.2. Geological map and cross-section of the Copper River area, Terrace, B.C. Geology by Mihalynuk 1984, 1985; Woodsworth et al. (1985); Tipper (1976); Monger (unpublished field data). The grid markers refer to those on NTS maps 103I/8 and 93L/5.

The most common unconformable association is between massive Lower Permian calcarenites and overlying conglomerates, although Triassic argillites are also rarely observed at the Mesozoic-Paleozoic contact.

An indeterminate thickness of highly deformed chert, pelitic chert, and sublitharenites are present about 7 km southeast of Mt. Attree (Fig. 76.2). There, planar bedded, pyritic, muddy chert gravel and sand grade upwards over about 10 m through calcarenite with pebbles outlining crossbedding; into pure, fossiliferous limestone with interbedded chert; and finally massive limestones with ash and lapilli interbeds (up to 20 cm thick).

A typical section of Permian carbonates comprises a lower argillaceous package (250 m) and an upper, thick bedded calcarenite (300 or more m; Monger, 1977).

Basal Conglomerate (15-100 m)

Just north of the immediate map area the Telkwa Formation rests atop Triassic argillite. In most places, however, the base of the Telkwa Formation is a conglomerate resting unconformably atop the Permian unit (the Triassic either never having been present, or having been removed by Late Triassic/Early Jurassic erosion). The conglomerate is 15-100 m thick and is composed of Permian carbonate blocks up to 2 by 0.5 m, but normally less than 20 cm across. The matrix contains iron oxide stained carbonate cement and volcanic debris.

Blocks of soft sediment deformed Upper Triassic (Karnian) argillite (up to 3 m across) occur within this basal member elsewhere in the Terrace map area (Woodsworth, personal communication, 1984). Tipper and Richards (1976) considered the Telkwa Formation to be Pliensbachian to Sinemurian. The probability that some of the basal Telkwa in the Terrace map area is Late Triassic raises a stratigraphic problem not resolved by the present work.

Lower Member

The lower member is between 0.75 and 1.5 km thick and is composed of agglomerate and breccia with subordinate tuff and flows. The most striking characteristic of this unit is the abundance of pyroxene phenocrysts (and to a lesser extent, hornblende, especially near the top) comprising as much as 30% or more of the sample.

Middle Member

The middle member is between 2.5 and 3.5 km thick. It is a highly variable assemblage of breccia, tuff and flows. Epiclastic units (20-50 m thick) are also an important constituent. Bladed-feldspar porphyry flows are widespread (feldspars 2 to 3 cm long). Flows are typically 1-3 m thick, and composite flows reach 55 m in thickness. A mauve ignimbrite in the central part of the middle member is a conspicuous marker horizon. It is typically 15 to 45 m thick, and contains strongly flattened purple pumice blocks up to 80 cm across. In a very general sense, it separates a more basic lower stratigraphy from more felsic, younger volcanics.

Upper Member

The upper member type section is located on the east side of the Clore River (Fig. 76.2). Total thickness of this unit is greater than about 0.75 km. It is distinguished by a sequence of bedded silt- to gravel-sized epiclastics (210 m); overlain by red, zeolitized lithic lapilli and vitric ash tuffs (190 m); a zeolitized, quartz and feldspar rich (15 and 50% respectively) crystal ash tuff (115 m); and 65 m of grey dacite.

The dacite is laterally extensive, thereby constituting a good marker horizon. It is feldspar rich, containing sparse lithic lapilli fragments and flattened feldspar rich pumice blocks (15 cm). Located 25 m from the bottom of the dacite is a 5 m thick red lithic ash tuff which is also laterally continuous. Atop the grey dacite is recessive lithic ash tuff with beds several centimetres to 1.5 m thick. A well indurated and banded (welded?) feldspar crystal, vitric ash tuff (15 m) is included for a composite thickness of 125 m.

Lithology of the topmost part of the upper member differs between the north and south ends of the ridge east of the Clore River. On the north end there are more than 100 m of siliceous mudstones; on the south end, lahars, tuff and rare feldspar porphyry flows are present. Upwards in section these lithologies appear to give way to well bedded lithic lapilli and ash tuffs which may be related to the Red Tuff member (Nilkitkwa Formation) of Tipper (1976).

Rocks shown as the Red Tuff member by Tipper (1976) are poorly exposed where mapped (Fig. 76.2) so that thickness is only crudely estimated at 200-500 m.

Ashman Formation

At the top of the volcaniclastic section are rocks of the Ashman Formation (Tipper, 1976). These are thinly bedded (2-20 cm) argillaceous siltstones to glauconitic sandstones with packstone horizons composed of pelecypods (notably **Trigonia**), brachiopods, and ammonite hash. Ammonites collected from that horizon are Middle Bathonian to Early Callovian based on preliminary identification of **Lilloettia** and **Xenocephalites** by R.L. Hall at the University of Calgary.

Changes in the orientation of bedding from below to above the contact may be due to an angular unconformity. However, abundant slickensided fractures within the volcanic tuffs, as well as slightly undulatory bedding in the marine sediments, point to a faulted contact.

Alteration and metamorphism

Alteration within the volcanic rocks is widespread. Glass and primary ferromagnesian minerals (notably olivine) have, in general, been totally altered. In the lower member, pyroxene and rarely hornblende have survived. Highly indurated lithologies such as flows are most apt to contain surviving ferromagnesian minerals. Even so, olivine can only be inferred to have existed from the presence of iddingsite pseudomorphs. The effects of alteration on the minerals makes it very difficult to accurately classify most flow and pyroclastic units except on a textural basis.

Hydrothermal metamorphism to zeolite and prehnite-pumpellyite facies appears to be regionally developed. Field evidence indicates that facies distribution is in part depth related. In general, the mauve ignimbrite marks an upwards change from prehnite-pumpellyite to zeolite facies. This change not only represents a decrease in depth-related pressure and temperature, but also a change to more acidic compositions higher in the stratigraphy.

In the contact aureoles of Mesozoic stocks and large Tertiary apophyses, rocks of albite-epidote hornfels and greenschist facies are found. Where Permian carbonates are within 2 km of intrusive contacts a well developed skarn assemblage (grossular, tremolite, epidote, ± diopside) is developed, and may locally host lenses (5 cm thick) of chalcopyrite.

Structure

Deformation within the map area is dominated by thrust faulting in the west, and block faulting in the east. Westward-directed thrust faults interleave Permian limestones with lower member volcanics. About 6.5 km southeast of Mt. Attree, the thrust plane is outlined by 2 m of chlorite schist and a foliation is developed in a zone subparallel to both the intrusive contact and the fault plane. Within this zone, greenschist facies rocks are present; these contain sheared carbonate lenses more than 5 m across.

Aphophyses from granitic dykes related to Tertiary granitic bodies commonly show no chilled contacts, perhaps indicating that moderately high temperature existed within the country rocks prior to dyke intrusion. Although the effect is probably a result of the advancing thermal front associated with a large intruding body, it is obvious from thrust faults crosscut by the intrusion that the volcanic rocks were subjected to an earlier deformation. These dissected thrust faults acted as pathways for fluids associated with the granites and now host a well developed skarn assemblage. The thrusts appear to have been rotated into their present position, dipping steeply to the east. This rotation may be coincident with formation of the homocline that characterizes the regional structure. Minor antithetic(?) block faults crosscut the thrust planes.

Block faults also repeat the stratigraphic section, as can be seen from the repetition of the grey dacite marker on the ridge east of the Clore River (Fig. 76.2 and 76.3). Detailed mapping shows that this repetition was produced by normal faulting (or high angle reverse faulting if deformation was pre-structural tilting). Similarly, block faulting repeats the mauve ignimbrite marker within the central part of the map area. Two major block faults with a stratigraphic throw of some 5 km divide the map area into thirds and result in the repetition of major stratigraphic subdivisions. In this interpretation, the faults are thought to be block faults rather than thrusts because no evidence for the latter was found.

The thermal metamorphic halo associated with a Late Cretaceous dioritic stock about 14 km east of Mt. Attree affects the rocks on both sides of the westernmost major block fault. This suggests that faulting predated Cretaceous intrusion. In addition, the intrusive body likely utilized the structurally weakened zone during emplacement.

Summary and conclusions

The Lower Jurassic Telkwa Formation and related units form a moderately east-dipping homocline, and outcrop for 25 km in their dip direction. The volcanic pile can be subdivided into basal, lower, middle, and upper members.

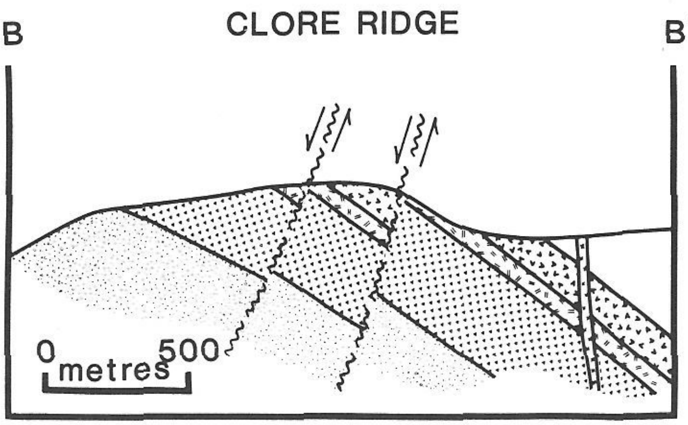


Figure 76.3. East-west cross-section of the ridge east of the Clore River (line B-B' on Fig. 76.2). The style of deformation is dominated by block faulting. Grey dacite marker is a resistant horizon forming the ridgetops. Patterns are the same as on Figure 76.2.

Prehnite-pumpellyite facies metamorphism dominates the lower volcaniclastics whereas zeolites are developed in the upper parts of the volcanic package.

In the field area, the Telkwa Formation consists of pyroclastics (60-70%), flows (20-30%), and epiclastics (10-20%) (Fig. 76.4). The total thickness of 6 km is not geologically unreasonable. For example, 11.3 km of volcanic derived rocks (10% pyroclastics, 90% volcanic sand and siltstones) are found in the Southland Syncline of New Zealand (Boles and Coombs, 1977). Furthermore, the Karmutsen volcanics on Vancouver Island form a volcanic pile 5.5 km thick (Surdam, 1973).

Deformation is dominated by west-directed thrusts in the west, and by block faults in the eastern part of the map area. Thrusts interleave the lower member with Permian carbonates. Block faults produce apparent repetitions of the volcanic stratigraphy causing the 6 km section to outcrop across the map area despite highly consistent dips to the east.

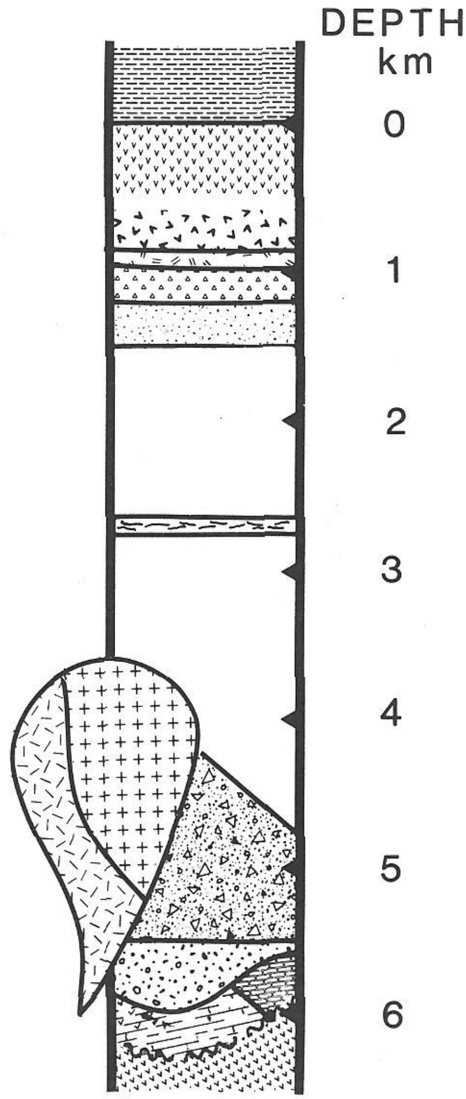


Figure 76.4. Stylized stratigraphic column showing the relationship between the volcaniclastics and adjacent lithologies. Patterns are the same as for Figure 76.2.

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