FIELD STOPS IN CENTRAL SWITZERLAND

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

VARVES IN THE WALENSEE

LOCATION

The Walensee can be seen anywhere along the Swiss Route N3 which runs south of the Walensee. The varves are not that easily found, because they lie on the bottom of the lake.

FIGURE 1. View of the Walensee. The high hills in the distance are part of the Cretaceous Säntis-Drusberg Nappe.

A CREATION-FLOOD PERSPECTIVE

One of the challenges to creation is the presence in lake deposits of many thousands of thin layers less than one mm in thickness called varves. A single varve is thought to have been deposited in one year, as determined by seasonal factors. Hence, when one finds 13,000 varves in some European lakes, this suggests a timeframe beyond the few thousands of years with which many creationists are comfortable. In addition, the Green River Formation in the northwest United States has some 5 million layers which have been interpreted as varves, but this is most likely a precipitation process and not the kind of transport feature found in the Walensee (Fig. 1). A recent study (Lambert and Hsü 1979) of the rate of formation of "varves" in the Walensee indicates that the average rate of formation is greater than 2 per year; sometimes as many as 5 per year were produced. It appears that each major storm may produce a layer that can be interpreted as a varve. The same report suggests that the varves in Lake Zurich are annual, but this is questioned (Giovanoli 1979). The question of the annuality of varves is complex. Associated scientific literature dealing with this topic is extensive.

References

Giovanoli F. 1979. A comparison of the magnetization of detrital and chemical sediments from Lake Zurich. Geophysical Research Letters 6(4):233-235.

Lambert A, Hsü KJ. 1979. Non-annual cycles of varve-like sedimentation in Wallensee, Switzerland. Sedimentology 26:453-461.

FIELD STOPS IN CENTRAL SWITZERLAND

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

THE GLARUS OVERTHRUST

LOCATION

Take the road south from Glarus to Schwanden. Just north of Schwanden, take the road going southeast to Elm for almost 2 km. After you leave the last group of houses on the west side, you will find a small parking area on the right where you should stop. Walk back about 100 m to steps and a path up the hill to the east. The Glarus overthrust view is in the forest east of the path.

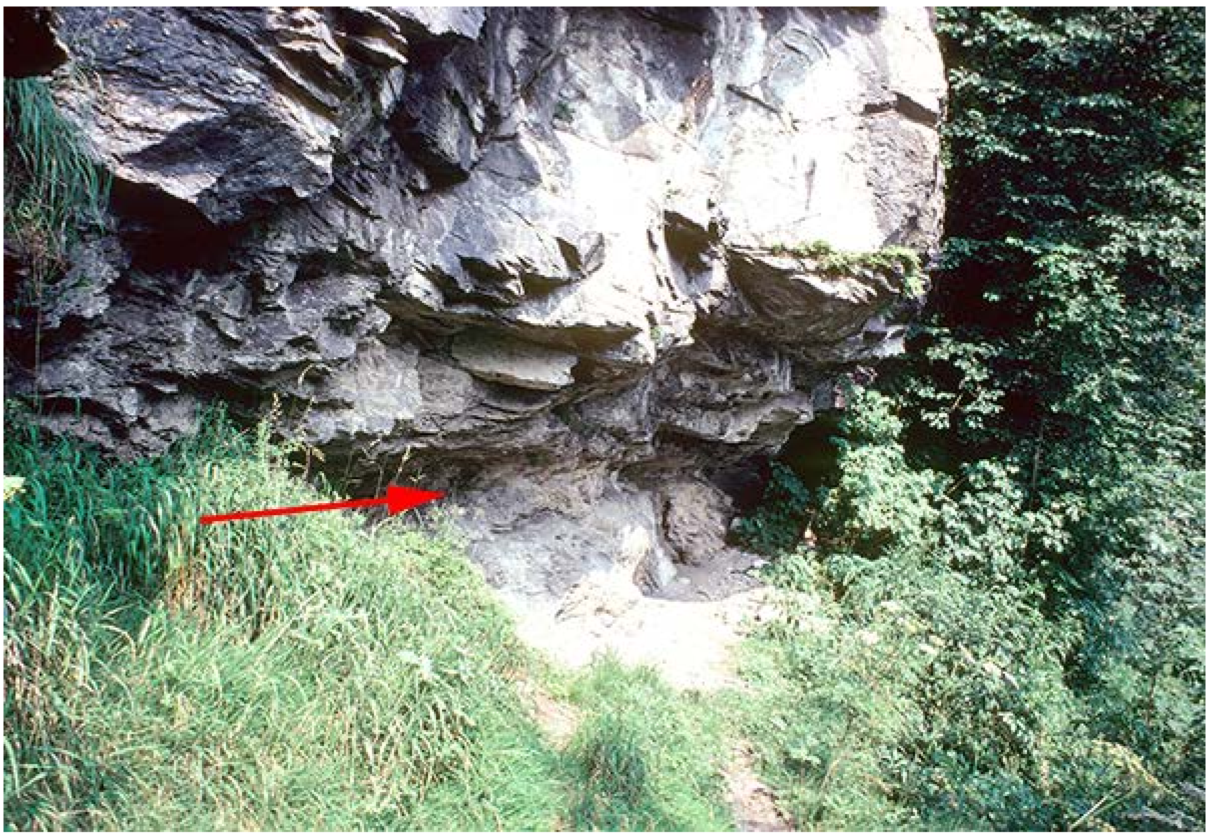

FIGURE 1. Thrust fault contact between the Eocene flysch (below) and the Permian Verrucano (above) near Schwanden. The arrow points to the fine contact line.

DESCRIPTION

This is probably Switzerland's most famous geologic feature which gave birth to the "outrageous" concept of large-scale movement in the Alps. The relationship is better exposed elsewhere but not as accessible.

Here are layers in a different sequence than is normally found elsewhere. The difference is explained on the basis of widespread (25 x 50 km area) overthrusting of older layers over younger ones. Arnold Escher, who discovered this in 1840 but did not publish his find, once told his student Albert Heim, "No one would

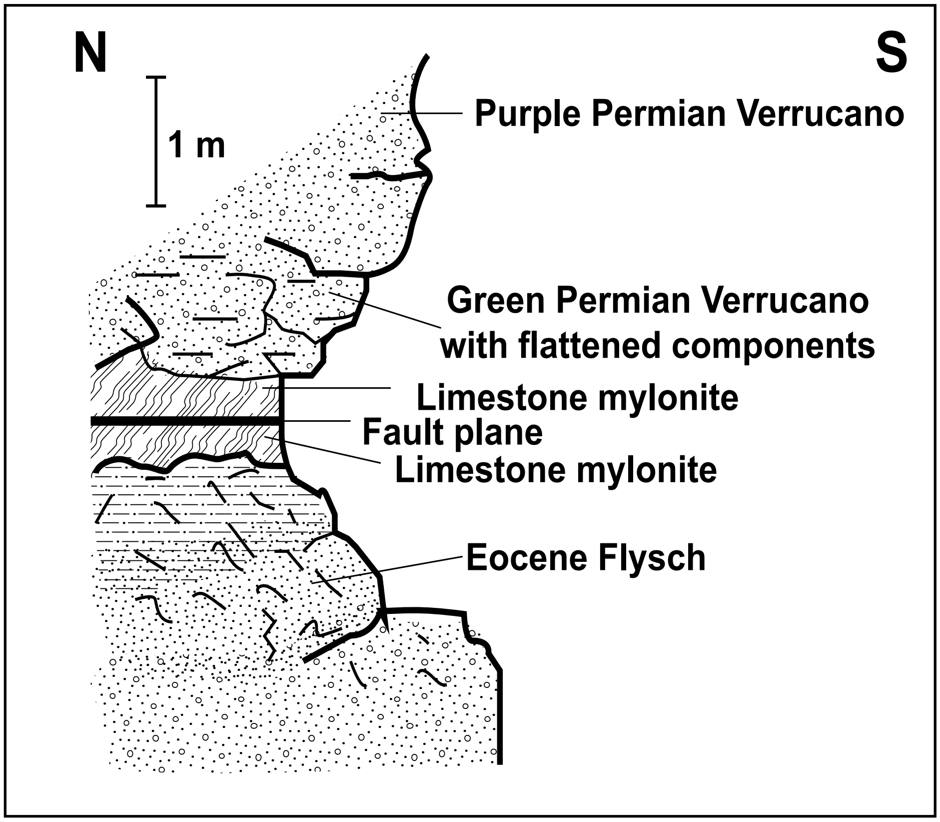

FIGURE 2. Interpretation of the units seen in the vicinity of Figure 1.

believe me; they would put me into an asylum." The concept was eventually accepted and was applied to much of the Alps.

The arrangement at this location is given in Figures 1 and 2.

Here the Permian Verrucano is *above* the Eocene flysch with a thin, fine-grained limestone mylonite (formed by grinding) between. According to the stratigraphic column and also according to the arrangement in other localities such as east of the Wallensee, this is reversed and is explained on the basis of a widespread thrust of the Permian Verrucano over the Eocene flysch. The limestone mylonite (Lochseiten Limestone) is usually only a few centimeters to meters thick. Across the valley note the disturbed Eocene flysch in the stream bed.

A Creation-Flood Perspective

This is one of the examples used by some creationists to point out the invalidity of the fossil sequence and the geologic column, because the Permian is over the Eocene. However, because of the obvious evidence for movement here, this is not a good argument. Perhaps this locality illustrates the abundance of movement that would be expected during the Genesis flood. There are other creationistic explanations for the normal order of fossil sequence.

FIELD STOPS IN CENTRAL SWITZERLAND

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

ZUG 1887 CATASTROPHE

LOCATION

The site of the catastrophe is at the northeast end of the Zuger See in the town of Zug along the lake at Vorstadt street.

DESCRIPTION

This celebrated flow of 1887 has been carefully studied and is significant both as an example of catastrophism and of a turbidity type of flow.

FIGURE 1. Town of Zug after the 1887 catastrophe.

The city of Zug is built in part on the unconsolidated sands of an old delta. The shoreline along this old delta was being extended and a retaining wall was built. Cracks appeared in the new landfill, but work was continued until 5 July 1887, when two underwater slides terminated the project. At 15:35 two houses and a section of sea wall sank suddenly into the lake. Seven lives were lost. At 18:50 a great commotion was noted in the lake — later interpreted to be the foundering of older lake sediment under the load of new sediments. At 18:55 strip after strip of land on the shore subsided so that an area extending 150 m along the shore and 80 m inland had sunk 7-8 m, destroying more houses (Figs. 1 and 2). About half of the sunken area was old land.

A subsequent study including 3200 soundings in the lake showed two extensive mudslides originating from the shore.They were estimated to have traveled several meters per second. The first flow was broader, extending about 0.5 km into the lake; a second one was 200-250 m broad, extended more than 1 km, and up 4 m thick. This second flow eroded a trench in the first flow. The average slope was 4.4%. The volume of material displaced was estimated at 150,000 m^3. While this example illustrates how sediments can be distributed underwater quite rapidly, much larger and more rapid underwater mudflows have been recorded.

FIGURE 2. Town of Zug about a century after the 1887 catastrophe. Note some of the same church steeples on the far side of the lake.

FIELD STOPS IN CENTRAL SWITZERLAND

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

MYTHEN KLIPPEN

LOCATION

These impressive steep mountains are located northeast of the town of Schwyz and can readily be observed from many places around the towns of Seewen, Schwyz, or Ibach.

Figure 1. Looking east into the Mythen Klippen near Schwyz.

DESCRIPTION

The Mythen (Mithen) are the best publicized example of outliers in the Alps. Their jagged topography is in sharp contrast to the soft hills of Ultrahelvetic flysch on which they lie. The stratigraphic sequence is out of order with the Mesozoic Klippen lying on top of Tertiary Eocene flysch which in turn covers other Mesozoic formations. The out-of-order sequence is explained on the basis of transport of a Mesozoic nappe fold(s) over the Tertiary flysch. The position of Grosser mythen over part of Kleiner Mythen (Fig. 2) indicates some transport.

The origin of the Mythen has been a matter of conjecture. Some older interpretations include: 1) the suggestion that the younger, lower layers are only plastered around the base and not below; 2) the possibility that the Mythen rose like a plug from below, with steep faults around the base; and 3) the interpretation of the old age for the Mythen layers based on fossils is incorrect. It is now accepted that they represent transported

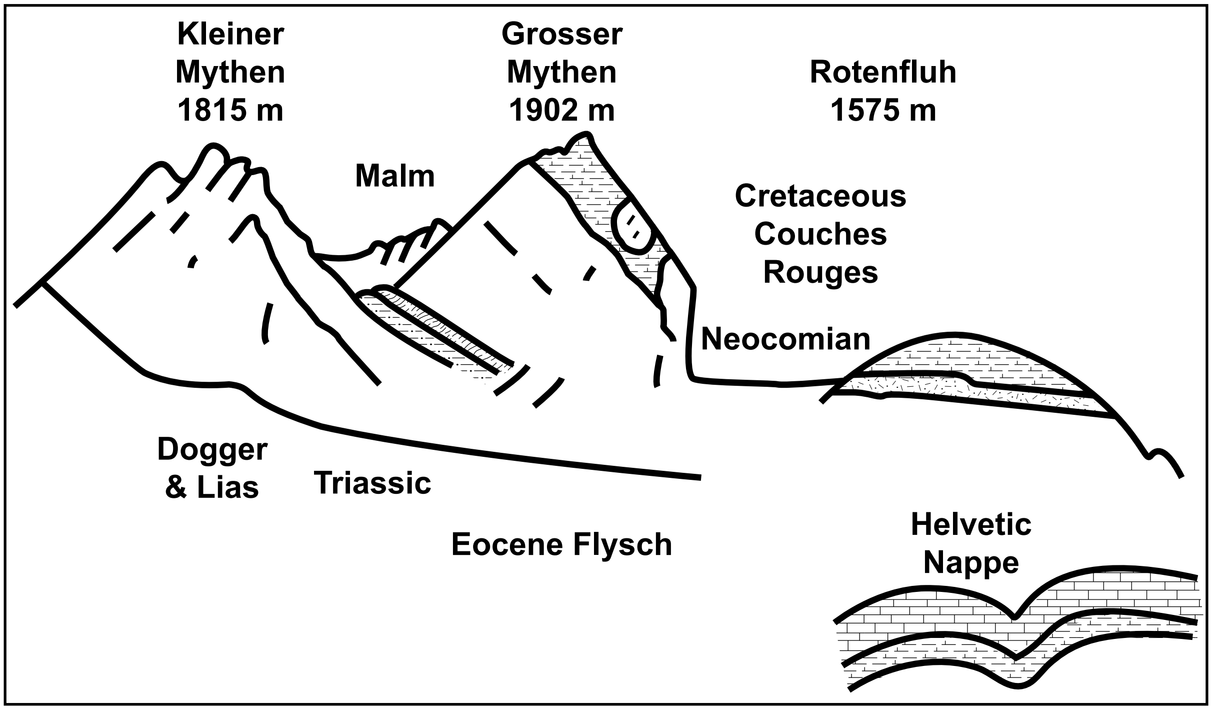

FIGURE 2. Identification of the geologic layers in the Mythen..

sedimentary layers, but their origin (i.e., previous location) is puzzling. The facies of the layers do not match at all that of the Helvetide folds (Wildhorn or Säntis-Drusberg Nappe) found below and to the south (Fig. 2) and could not have the same source. Some have postulated that they might have come from the higher Austrides (Africa?) but this is often doubted. There are facies affinities between the Mythen and the Sulzfluh Nappe of the Graubünden of east Switzerland and also the Median Prealps nappes to the west. They probably came from the south from a similar source.

The Mythen are interpreted as erosional remnants of a widespread nappe. Why they should have been spared from erosional factors while most of the rest of the nappe in this region has been removed is no doubt related to the question of their origin. It does not appear that ordinary weathering would remove most of a nappe and leave a few conspicuous isolated remnants. A slow process of rock weathering would not be expected to spare the Mythen. Weather fronts over long ages would not always skip over where the Mythen were to remain. Glaciation and river runoff would produce more localized erosion, but to leave such extremely isolated blocks seems odd for any normal process. One also wonders if the Mythen could not have been transported as isolated blocks to their present position.

A Creation-Flood Perspective

The whitish, round block of Malm in the Cretaceous Couches Rouges near the top of the Grosser Mythen (Figs. 1 and 2, right peak) can raise the question of the competence of the Malm limestone for recycling during the flood. Why should it already be hard enough to be trans ported as a mass? For some suggested answers, see the discussion for the wildflysch of Chantemerle (p. 13).

Field Stops in Central Switzerland

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

Mount Pilatus

Location

Mount Pilatus is located south of the town of Lucerne. A good view of the fold structure can be obtained by going to the town of Alpanach-Stad and taking the cog railroad to the Esel. Hike up to the peak of the Esel above the station.

FIGURE 1. View to the east (right) as one ascends Pilatus. Note the near-vertical layers of rock in the left side of the picture.

Description

Mount Pilatus gets its name from its fractured appearance and its reputation as a locale for angry storms. One of the legends purports that Pontius Pilate, after delivering Christ to the Jews, was cast into prison by the Roman Emperor Tiberius. There he took his life. His body produced storms wherever it was taken — including Mount Pilatus, where it caused terrific devastation. Local laws prohibiting access are reported for 1469, 1564, and 1578 A.D., indicating the fear and respect for the mountain.

On the way up the cog railroad, note the finer flysch sediments at the base, blocky limestone up higher. On the east (right as you face the direction of travel) note some very steep layers (Fig. 1). Higher up, take a good look to the west to the high peak called Matthorn (Fig. 2) and note the contorted layers. These were originally deposited in a horizontal or near-horizontal position.

FIGURE 2. View to the west (left) near the top of Pilatus. Note the very contorted layers. sliding was from the south (left of picture).

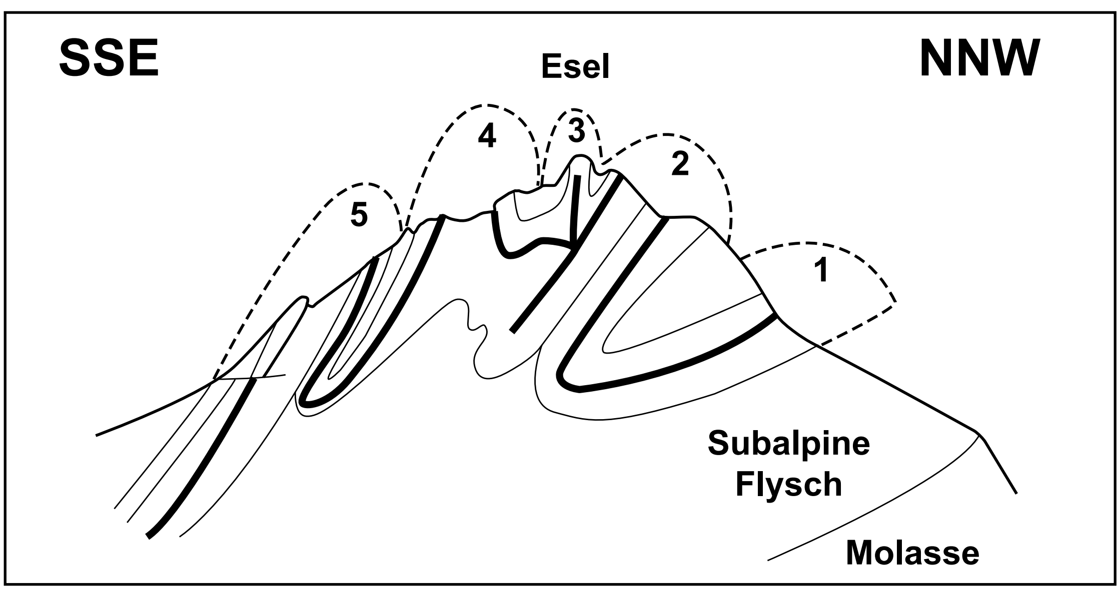

FIGURE 3. Section through Pilatus in the region of the Esel showing five folds forming the “breakers” at the nappe front. The nappe (probably the Wildhorn Nappe) came from the south (left).

From the top of the Esel, view the contorted nature of the structure of Pilatus. The layers you see are almost all Cretaceous. This is a good example of the breakers at the foot of the nappes; in this case probably the Helvetide Wildhorn Nappe. The usual folded structure common at the foot of nappes is in contrast to the generally flat nature of nappes and is used to support the concept of gravity tectonics, instead of a push from behind which would tend to contort the entire nappe. This contorted nature can be contrasted to the much-flatter Permian Verrucano seen south of Glarus which is not at the front of the nappe.

The chaotic nature of the layers seen here has more order than is at first apparent. Figure 3 illustrates a set of five partially eroded folds (nappes) found in Pilatus. These folds are interpreted as the result of gravity sliding from the south. As the nappe slid down from the south, the frontal portion became folded (crumpled) into five folds as it met resistance in the region of Mount Pilatus.

The Esel is fold 3, Matthorn to the southwest is fold 5, while Tomlishorn beyond the hotel to the east is fold 2. To the east, projecting into Lake Lucerne, is Bürgenstock which is a continuation of the formations of Pilatus. To the southeast is Stanserhorn and beyond is Buochserhorn which, like the Mythen, are klippen (outliers) of the Median Prealps type. Rigi to the northeast across the lake is composed of uplifted molasse. The eastern Alps are to the east and the Bernese Alps to the southwest. On a very clear day you can see the Jura to the northwest.

A Creation-Flood Perspective

The concept that the Alps were formed by slow thrusting from the south would challenge any rapid flood event. The presence of breakers (folds) at the foot of the nappes favors gravity sliding tectonics which can occur rapidly. The breakers at the front of the nappes are a common feature of the Alpine nappes. That nappes should be moved around by gravity suggests conditions in the past quite different from the present. At present, gravity sliding of such dimensions has not been noted. The near-vertical layers on Pilatus seem stable. The breakers are evidence for catastrophism.

FIELD STOPS IN THE VALLEY OF THE RHÔNE

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

WILDFLYSCH OF CHANTEMERLE AND THE OVERLYING GURNIGEL NAPPE

LOCATION

From the Vevey autobahn exit (east end of Lake Geneva) go east through Blonay towards La Chanaz. When you reach high electric power lines, take the road to Chantemerle. The wildflysch is exposed in the roadcut to the left just before you reach the "Chemin du Poyet" sign. To reach the Fayaux Quarry in the Gurnigel Nappe, follow the road to Les Pléiades, turn right in Alliaz. The quarry will be on the left. Get permission to enter the quarry.

DESCRIPTION

You are in the north part of the Prealps. The Prealps have come from at least dozens of kilometers to the south, and are composed of at least 7 allochthonous units assumed to have traveled north during Eocene-Oligocene with subsequent deformation during the Neogene.

The wildflysch of Chantemerle is exposed at this field locality (Fig. 1). It lies at the base of the Gurnigel Flysch and rests on Ultra Helvetic nappes which in turn rest on molasse. It is assumed to have formed by gravity sliding of clasts ahead of the advancing allochthon. Wildflysch is characterized by having large inclusions (sometimes up to 2 km) that are often associated with catastrophic conditions. It is probably found between all the nappes of the Prealps and is interpreted as a subaqueous oceanic deposit. This is in contrast to the contact between the Helvetic nappes, which is mylonitic (from grinding) and considered more dry.

FIGURE 1. Wildflysch of Chantemerle. Note the backpack in the lower right corner for scale. Many inclusions can be seen, including a large one which fills the center of the picture.

Examine the wildflysch for inclusions. These originate from Helvetique, Ultrahelvetique, and Penninic paleogeographic domains and are of Jurassic to Eocene stratigraphic divisions. These are deformed (note direction of flattening) but must have had some competence at the time of accumulation. Look for joints in the deposit. The overthrust of the Gurnigel Nappe above would produce considerable deformation pressure.

The Gurnigel Nappe itself is a flysch with abundant turbidites (Fig. 2). It can be examined at the Fayaux Quarry above this locality. The nappe is an isoclinal slice with a thickness of 1600 m, assumed to have been originally deposited in a deep oceanic environment below the carbonate compensation depth in Late Cretaceous to Lower Paleocene time in the Penninic paleogeographic domain. It was transported north during the Eocene-Oligocene epochs leaving some traces above the Median Prealps, which in turn overthrust the Gurnigel Nappe during the Neogene.

FIGURE 2. The Fayaux Quarry exposes many turbidites of the Gurnigel Nappe. Each light-colored layer is part of a turbidite. Note people for scale.

A Creation-Flood Perspective

The competence of fossil-bearing clasts (inclusions) in the wildflysch of Chantemerle suggests induration of the original source from which they were derived, being recycled into the wildflysch. The presence of hard inclusions from other nappes has been suggested as a problem for a flood model, as time would be required to harden the sediments forming the inclusions which might not harden in a year. However, cementation can occur rapidly, especially under high pressure, and the inclusions may not have been completely endurated. Also, soft nappes could contain large, hard inclusions formed before the flood. Both soft and hard components could originate from the same general preflood source area of a nappe. Transport systems do not preclude moving both soft and indurated components. In transport, a mixed source or selected break down during transport would be expected to produce mixed deposits unless factors favoring sorting dominated.

Field Stops in the Valley of the Rhône

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

Niesen Nappe at Le Sépey

Location

From Aigle take the road to the northeast towards Les Mosses. Just beyond the town of Le Sépey stop at the junction of the road to Les Mosses and Col du Pillon. Good turbidites can be found at the beginning of the roadcut of the road to Les Mosses.

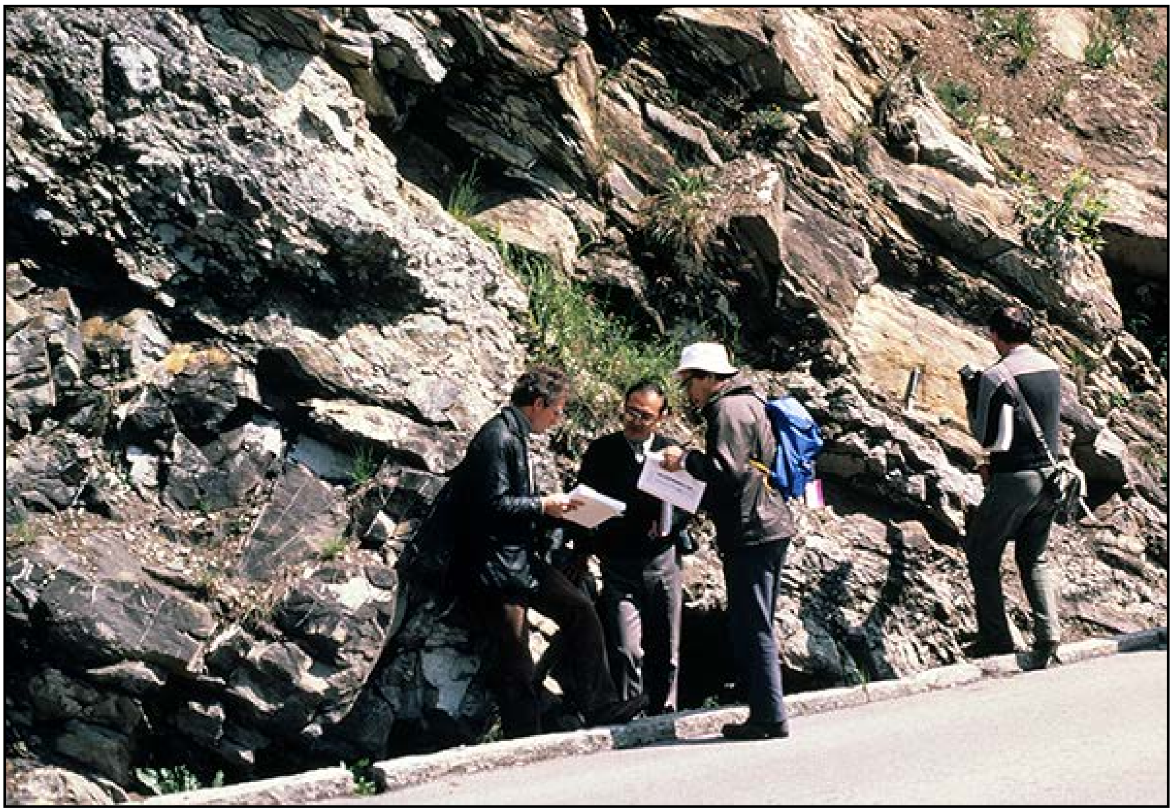

FIGURE 1. Turbidites and debris flows of the Niessen Nappe above the town of Le Sépey.

Description

You are at an overturned section of the Niesen Nappe. To the east from the junction (towards Col du Pillon) you will note some massive coarse Middle Jurassic limestone layers on the north side of the road. A few ammonites have been reported here. To the west from the junction (up the road towards Les Mosses) are Late Cretaceous turbidites and debris flows. They are well developed at the section of the roadcut, up from the junction (Fig. 1).

Examine this outcrop for turbidites (finer sediments) (Fig. 2) and debris flows (coarse clasts in a fine matrix). The turbidites have an exceptionally well-developed Bouma sequence. Study the sequence in Figure 3 and compare to the outcrop.

Since this is an overturned section, the sequence will be bottom-side up with the A unit on top instead of the bottom. Also examine the debris flow which probably formed quite rapidly. Blocks with a diameter of 14 m have been described in this nappe.

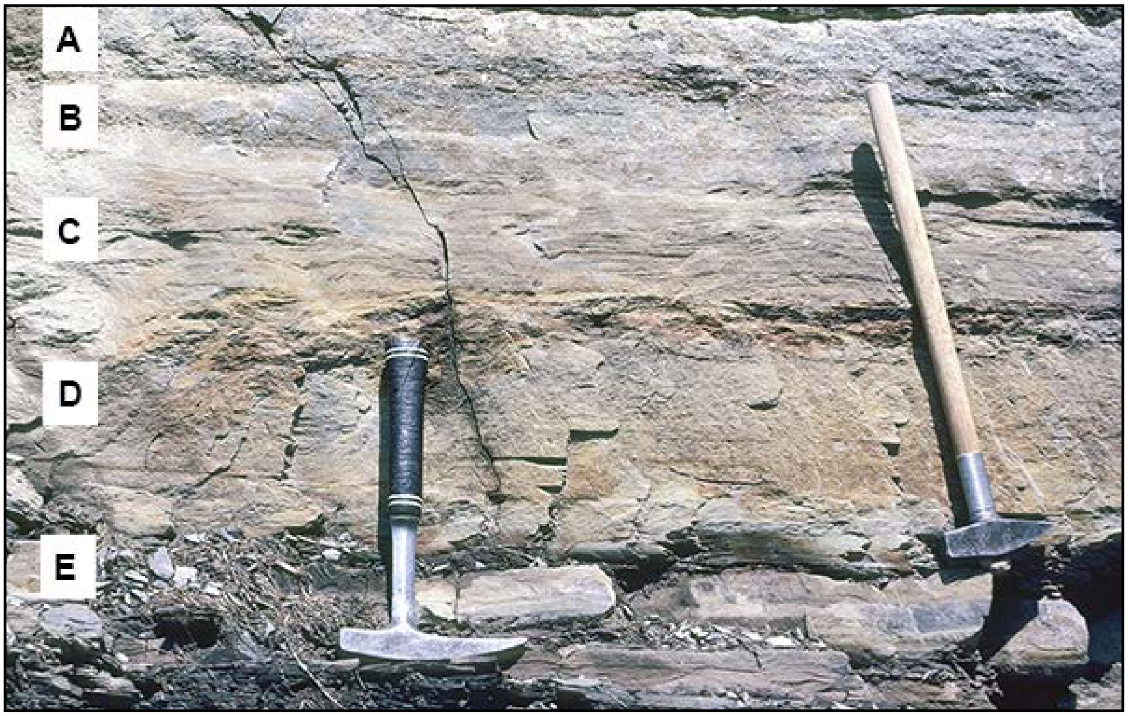

FIGURE 2. View of a single turbidite at Le Sépey. The letters identify the various units of the Bouma sequence (see Fig. 3). Note that the order of the units is reversed, because at this locality the Niesen Nappe is reversed.

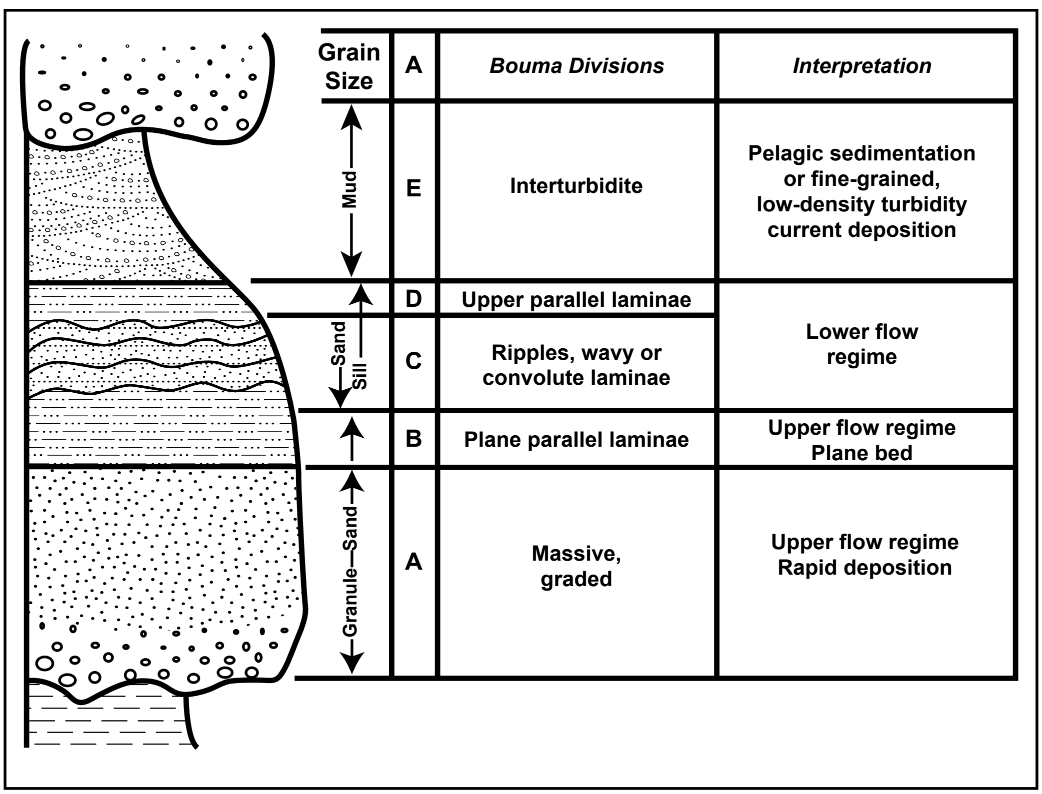

FIGURE 3. Bouma sequence of structures in a complete turdibite bed. (Modified from Middleton and Bouma 1973).

A Creation-Flood Perspective

The Niesen Nappe is interpreted as having been deposited at the base of a steep scarp in the ocean below the carbonate compensation level. It contains an abundance of coarse, terrigenous conglomerates and turbidites. An upper conglomerate in the nappe is believed to have been deposited by sheet flow. In other localities the nappe reaches thicknesses of more than 1000 m. The nappe gives evidences of an abundance of rapid, underwater deposition, and current interpretations fit well with a creation-flood model.

Reference

Middleton GV, Bouma AH. 1973. Turbidites and deep-water sedimentation. Society of Economic Paleontologists and Mineralogists Pacific Section, Short Course, Anaheim, California.

Field Stops in the Valley of the Rhône

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

Relationship of Nappes at Col de la Croix

Location

Take the road towards Col du Pillon. At the town of Les Diablerets go south to the Col de la Croix. At the Col a small hill northwest of the parking area offers a good panorama to the northeast. Conspicuously eroded gypsum deposits are seen if you climb to the east of the parking lot.

FIGURE 1. View to the east from Col de la Croix. See Fig. 2 for a geologic interpretation.

Description

Figure 1 depicts the view to the east, and it will help identify the major structural features. The extensive valley ahead of you is the Zone des Cols. It consists of marls, shales, and evaporites which are less competent than the rocks forming the hills to the sides. These marls, shales, and evaporites (gypsum) are easily eroded; hence, the valley. To the north is the Niesen Nappe; we are standing on the Ultrahelvetic Bex Nappe. To the east and southeast are the Diablerets and Wildhorn Nappes (Fig. 2). Note that the Wildhorn overrides the Diablerets. Also note the contorted frontal folds in these nappes. The third Helvetic nappe — the Morcles Nappe — is not exposed here. Some of the Triassic gypsum of the Bex Nappe is dramatically eroded to the east of the parking area. Rock salt is mined from the same evaporite source at the town of Bex to the southwest in the valley of the Rhône.

This is a good place to consider a general model for the formation of this part of the Alps. You should consult a cross-section of the Alps that illustrate suggestive steps in the gigantic compression movements that took place as the Alps were formed. On such an illustration, note the line near the top delineating the present skyline. Compare the proposed original position of the Helvetic nappes (Morcles, Diablerets, and Wildhorn), Ultrahelvetic nappes, and Niesen Nappe to their present position.

The following "classic" scenario is proposed but disputed:

1. Uplift of the Ultrahelvetic nappes and sliding of these to the northwest during Upper Eocene or Lower Oligocene. The process of gravity sliding caused what is called diverticulation of the Ultrahelvetic nappes where their order was reversed — the "originally" highest ones sliding down first and being covered later by originally lower ones as further sliding proceeded; thus, a reversal.

2. Uplift and folding of the Helvetic nappes forming the Morcles, Diablerets, and Wildhorn nappes. This is also thought to have occurred in Upper Eocene to Lower Oligocene.

3. Uplift of the Aiguilles Rouge and Mt. Blanc basement massifs (A.R. and M.B. on Fig. 1) during Upper Miocene and Pliocene causing further sliding of the Helvetic and Ultrahelvetic nappes to the north.

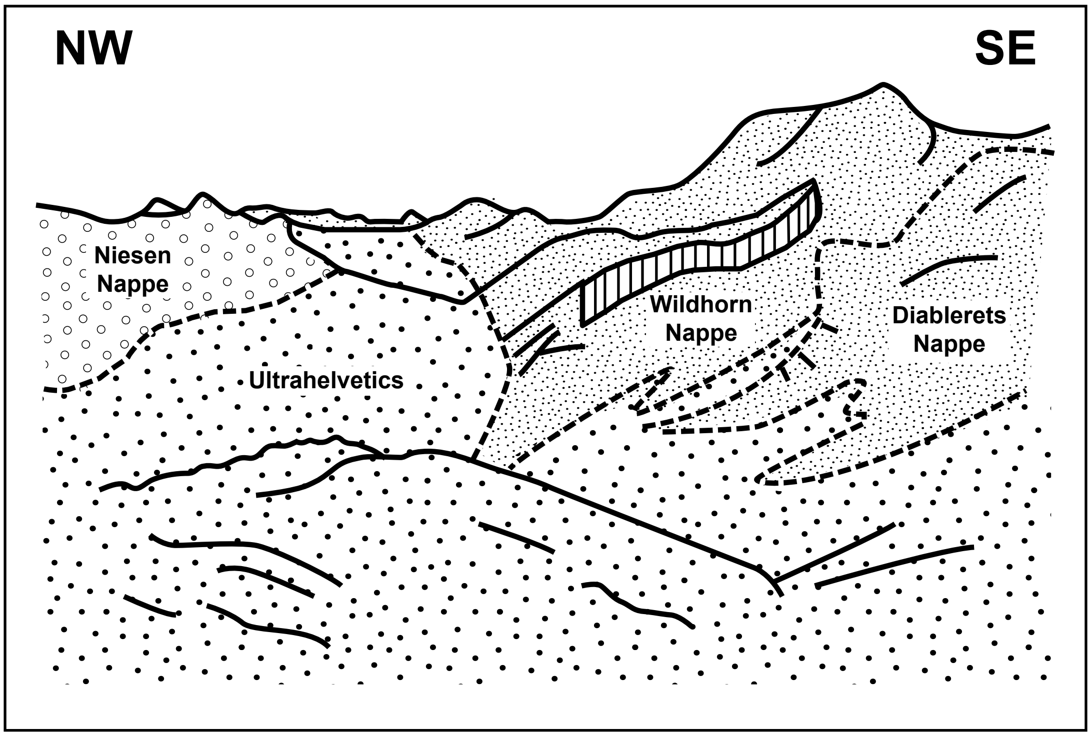

FIGURE 2. Interpretation of the view to the east from the Col de la Croix showing the relationship of the Ultrahelvetic, Niesen, Wildhorn, and Diablerets Nappes. (Modified from Matter et al., 1980, p 272).

REFERENCE

Matter A, Homewood P, Caron C, et al. 1980. Flysch and molasses of Western and Central Switzerland. Excursion No. 126A of the 26th International Geological Congress. Part B of Geology of Switzerland: A Guidebook. Basel & NY: Schweizerische Geologische Kommission, Wepf & Co.

Field Stops in the Valley of the Rhône

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

Glacial Erratic near Monthey

Location

From the town of Monthey take the road up the hill to the west towards Morgins. Stop at the large hospital. The object of our search is the rock just beyond the north end of the main hospital building. A house has been built on it.

Description

The famous Pierre des Marmettes (Fig. 1) is a glacial erratic, one of several such around this region. It was brought here by the movement of ice when the valley was glaciated. It is composed of Mt. Blanc granite which is not found near this region, and obviously had to be transported for many kilometers. A glacier would be the most likely prospect for performing such a move. The rock, which has an estimated volume of 1824 m^3, was described in 1841 by J. de Charpentier who enjoyed showing it to those of his friends who did not believe in glaciation. It is said to have been brought here during the later stages of the Wurm (latest) glaciation.

On a clear day a panorama of the Prealps (NE) and Helvetides (E) can be seen across the valley of the Rhône towards the east.

FIGURE 1. The glacial erratic Pierre des Marmettes. Note the house on top.

A Creation-Flood Perspective

The evidence for glaciation, such as the Pierre des Marmettes, and abundant other evidences are convincing indications of an “ice age.” Creationists postulate a single short period of glaciation very soon after the flood; probably brought on by volcanic activity. The fine volcanic ash in the atmosphere from flood activity would occlude the radiant energy from the sun, resulting in cool air. That cool air in combination with abundant moisture from warm oceans would favor rapid glaciation.

Field Stops in the Valley of the Rhône

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

Overturned Limb of the Morcles Nappe

Location

The overturned limb of the Morcles Nappe (Dents de Morcles) can be seen on the east side of the valley of the Rhône about midway between Bex and Martigny. A good location is above the town of La Rasse (near Evionnaz). A better view is obtained from the town of Mex several kilometers to the west.

Description

Looking at the skyline to the northeast, one sees the classic great cliff of the Dents de Morcles. See Figure 1 and find the thrust plane. The part above this plane is overturned, i.e., the stratigraphic column goes in the reverse direction (younger below older). This is the overturned limb of the Morcles Nappe which had a normal limb above the overturned one. The normal limb, which you can imagine folded back to the south high in the sky, has been eroded away. Below the overturned limb are flysch, Jurassic deposits and the crystalline basement of the autochthon.

FIGURE 1. View of the Dents de Morcles. The arrow at the right indicates where the Morcles Nappe (above the arrow) slid over the more fixed layers below. Here the layers of the Morcles Nappe are reversed, due to recumbent folding from the south (right). The arrow at the left, which is within the Morcles Nappe, points to the lower margin of the thin, dark Gault (Upper Cretaceous) layer. Just below is the thick Nummulitic limestone layer (Eocene). Standard geologic interpretations would suggest some 45 million years between these two layers; yet the thin Gault shows little evidence of any erosion for 45 million years (remember the Morcles layers are reversed here).

A Creation-Flood Perspective

In this overturned limb one can see a paraconformity (disconformity) with a supposed gap of 45-55 million years. Examine the picture and the cliff. The paracomformity lies between the darker Gault (estimated at about 100 million years ago) and the Nummulitic (estimated at about 44 million years ago), which on the hillside lies just below the Gault. There does not seem to be much erosion of the thin Gault (on its lower side in this overturned limb) during this 45 million (or more) year gap. This is an example of a number of such paraconformities that are widespread, yet very flat. The absence of erosion at these "gaps" suggest that the time gap is not real. The peneplain concept is an inadequate explanation.

FIELD LOCALITIES IN THE ZERMATT AREA

FIELD STOPS IN THE VALLEY OF THE RHÔNE

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

GORNERGRAT PANORAMA

LOCATION

Take the cog railroad from Zermatt to Gornergrat. At Gornergrat take the path to the south of the hotel to the viewpoint above and east of the hotel.

DESCRIPTION

This is a classic area for the study of the Penninic nappes. There are three main nappes here, dipping significantly to the west. The first is the Monte Rosa Nappe which is below the viewpoint and forms the hills to the northeast and southeast, including Castor to the south but not Pollux (which is composed of Mesozoic deposits). Hsü (1995, p 90) questions the validity of the Monte Rosa Nappe. The second nappe is the Grand Saint Bernard Nappe which can be seen to the northwest and is best identified by looking at the dashed pattern on Figure 1 and comparing it to the panorama you see to the west (Fig. 2).

Also by looking at the same sketch you should be able to identify the Dent Blanche Nappe (closely stippled) which includes the Matterhorn (4478 m). The rest (loosely stippled) is mostly Mesozoic deposits of carbonates, schists, ophiolites, etc. The town of Zermatt (1620 m) lies on these deposits.

As you look to the southwest you will note the Gorner Glacier and its branches. Note the lateral and medial moraines. The gray rocks just above the glacier represent fresh serpentine of the Mesozoic units, while the more brownish rocks above represent more weathered serpentine.

The first two nappes (Monte Rosa and Grand Saint Bernard) are traditionally considered Penninic in paleogeographic origin. In the Alps there has been a general move from S-N; however, the southern part of the Grand Saint Bernard Nappe (the part you can see which is called Mischabel) is interpreted as having moved to the south by backthrusting. The Grand Saint Bernard Nappe (Mischabel) does not appear to have been subjected to the high degree of metamorphism found in the Mesozoics surrounding it; hence, it is assumed to have slipped in after the metamorphism. The Dent Blanche Nappe (which includes the Matter horn) comes from the Austro-Alpine paleogeographic domain. This is usually interpreted as coming from a more southerly continent and being thrust north (probably during the Oligocene) to its present location.

When one considers how much effort it takes to lift a 50 kg object, one can only wonder at the energy involved in moving these mountains around, above, and under each other.

FIGURE 1. Panorama from Gornergrat looking towards the west.

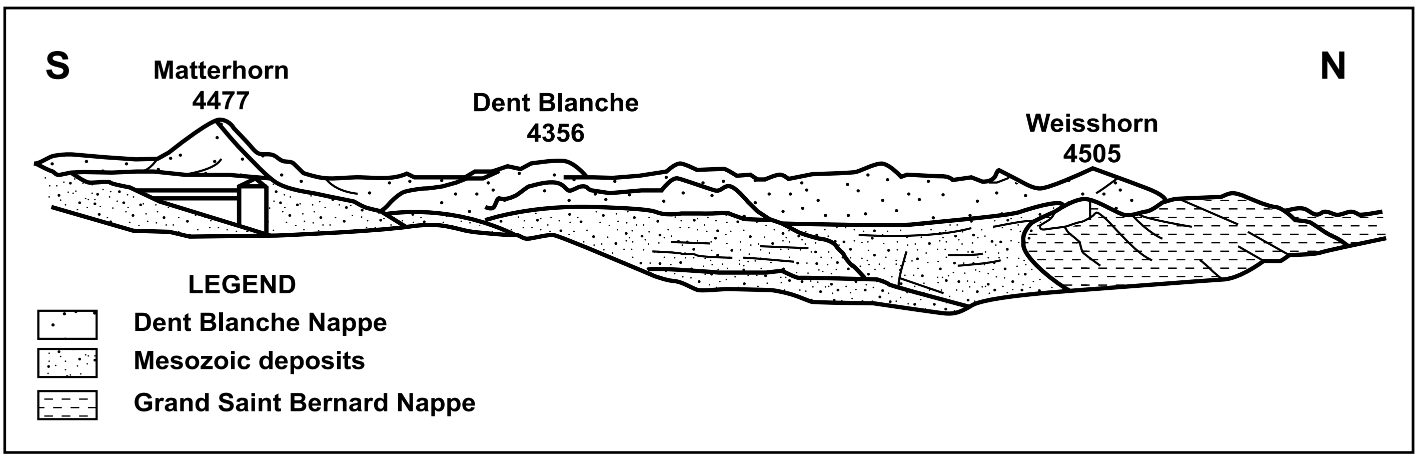

FIGURE 2. Interpretation of the panorama from Gornergrat looking towards the west.

Field Localities in the Zermatt Area

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

Gorner Glacier below Gornergrat

Location

Take the cog railroad to Rotenboden. The glacier can be reached by taking a leisurely walk (about 6-7 km round trip) along the cover of the Monte Rosa Nappe. Take the path to the south and then east along the south flank of Gornergrat until you reach the glacier.

FIGURE 1. Smooth mounded rocks called roche moutonné (sheep rocks) formed by the action of the Gorner Glacier on the crystalline basement of the Monte Rosa Nappe. Note the striations on the rocks in the lower left corner.

Description

The path to the east will go down through the cover (Permian and above) of the Monte Rosa Nappe and eventually reach the crystalline basement of the nappe before you reach the Gorner Glacier. Along this path are several kinds of metamorphic rocks or minerals indicative of metamorphic changes due to heat and/or pressure. The degree of metamorphism in the Alps tends to be high in this region, while it decreases gradually to the northwest. There is little left by the time you get to the Helvetide nappes. As you proceed down the path, look at the rocks along the side. Your geological astuteness may permit you to pick out the following rocks and special indicators of metamorphism.

Schists (Schistes Lustré, Bündner Schiefer) with shiny grayish mica

Quartzite — angular and sometimes schistose

Quartz pebbles in larger rocks

Bluish glaucuphane schist

Dark greenish, sometimes smooth, serpentine

Granitic rocks from the crystalline basement of Monte Rosa Nappe (there are several kinds of these)

Small brown-red garnets in crystalline rocks

On the way down also notice the Gorner Glacier and branches, including dark medial and lateral moraines, crevasses, sources, direction of flow, etc. At the edge of the glacier note the cracks in the ice and the bed it flows on. The smoothed-over rocks with striations (grooves) at the sides of the glacier are part of the Monte Rosa Nappe basement. Their rounded pattern gives them the name of roche moutonné (sheep rocks) (Fig. 1). The Gorner Glacier reaches a thickness of 200-300 m in the valley. It travels slowly at the rate of only a few meters per year. The glacier was much larger in the early 1880s. During the early Middle Ages and late Roman period one could travel readily from Zermatt to Italy, indicating less glaciation than what is seen now. Earlier the glaciers reached to Lake Geneva which has been gouged out to below sea level as a result of glacial activity.

A Creation-Flood Perspective

The degree of metamorphism in this region can be the basis for raising some interesting time questions. The pressure required for some metamorphic mineral assemblages here suggest an overburden with a depth of at least 30 km. More recently some suggest 100 km and even more than 300 km (Dobrzhinetskaya, Green & Wang 1996) for part of the Alps. If one should assume that metamorphism was 30 - 150 million years ago, as is proposed by the generally accepted geologic time scale, it would mean the Alps must have been eroded at a rate of at least 60 times faster than the probable world average of 30 m per 1 million years (corrected for humankind's agricultural pursuits). Something seems wrong. And if Alpine erosion *is* that rapid, one wonders why older mountain ranges of the world have not been flattened by erosion a long time ago.

This raises the question of general rates of erosion and the existence of continents and mountains. They would be expected to have been eroded away a long time ago. It has been argued that repeated uplift to form new mountains has occurred, and this would provide a source area for the sediments of the geologic column. The presence of very "old" mountain ranges such as the Caledonides of northern Europe and the presence of much of the geologic column in many parts of the world seem to mitigate against this idea, since the process of uplift and erosion would destroy old mountain ranges, and the geologic column in them would have been recycled many times during this time, yet much of it remains. At the rate of erosion of 30 m per 1 million years, the present continents would have been eroded, on an average to sea level, 150 times in 3 billion years. Of course, they can only be eroded once. At an average erosion rate, none of the geologic column or continents should still be present. The present rates of erosion pose a question for the standard geologic time scale.

Reference

Dobrzhinetskaya LF, Green HW, Wang S. 1996. Alpe-Arami: a peridotite massif from depth of more than 300 kilometers. Science, 271, 1841–1845.

FIELD STOPS IN THE JURA MOUNTAINS

The information for this field stop is taken from a guidebook prepared by Ariel A. Roth in 1998.

REEF STRUCTURE AT MARES QUARRY

LOCATION

From Saint-Germain-de-Joux (which is located 12 km northwest of Bellegarde-sur-Valserine, eastern France), go north towards Echallon for about 1 km. Turn left towards Plagnes and very soon make a second left on the private road to the Mares Quarry which lies ahead to the west. The quarry has been used for mining abrasives and the ripening of cheese.

FIGURE 1. Close-up view of fossil coral from the Mares Quarry. The block is about 1½ m long. Note the parallel arrangement of the numerous coral branches.

DESCRIPTION

This locale is part of the vast Kimmeridgian (upper part of the Jurassic) coralline complex of the Western Jura. Kimmeridgian ammonites below the complex and Portlandian ammonites above have placed this locality in the Upper Kimmeridgian. This region is interpreted as a back reef facies. To the east and much further south there is a massive coralline lime stone which is often recrystallized and which may represent a reef.

The region around the entrance to the quarries should be examined carefully for fossils, noting their orientation. Remember that corals usually grow vertically; a few grow horizontally. Coral heads (Fig. 1) are common here. Stromatoporoids (extinct sponge-like organisms that form layered deposits) are occasionally present. Above the opening of the caves a sedimentary carbonate breccia layer is described.

The coral heads are described as growing in large columns and are said to go as far as 40-50 m below the floor of the quarry. The part exposed here represents the top region of this sequence of coral deposits. Between the coral units is a pseudo-oölithic deposit, reported to show no bedding; hence, it is assumed that it was deposited rapidly and the coral also grew quite rapidly to keep from being buried. Burial eventually caused death of the coral. The breccia above the coral is interpreted as representing a shallow, high-energy environment.

A Creation-Flood Perspective

The orientation of the coral gives an equivocal picture as to whether this could be a true reef environment. Mostly horizontal growth (represented by the horizontal coral here) is not common to present reefs but would be expected in a transported deposit, since a horizontal position is more stable. It should also be noted that the presence of coral heads not in position of growth is not a good criterion of an allochthonous deposit, since heads not in position of growth occur on present reefs when they break down during storms, etc. The presence of all heads in position of growth would be a strong indication of autochthonous formation, but the mixed picture here would fit either an allochthonous or autochthonous model. Probably the most serious objection to interpreting this as a true reef environment is the reported absence of bedding in the pseudo-oölithic rock matrix between the coral. It is difficult to conceive of no bedding being formed by changing depositional environments during the many years it would take for the coral heads to grow. More rapid transport may be represented here.