Field trips in the Israeli high school geology curriculum

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Introduction

Israel has very limited natural geological resources such as oil, gold and other scarce and valuable minerals. In contrast, the very diverse Israeli landscape, rich with geological phenomena, makes this country a paradise for geology educators.

Geology achieved the status of an independent scientific discipline in Israeli high schools very recently (Orion et al. 1986). For the last five years, a small group in the Science Teaching Department of the Weizmann Institute has been involved in the planning and developing of a high-school geology curriculum, as well as its implementation and evaluation. However, the entry of geology into schools is very slow and the implementation and evaluation have been carried out in a few classes with geography teachers that are geology oriented.

Directions in the development of the high school curriculum

The conceptual framework that guided the curriculum development is illustrated in Figure 1.

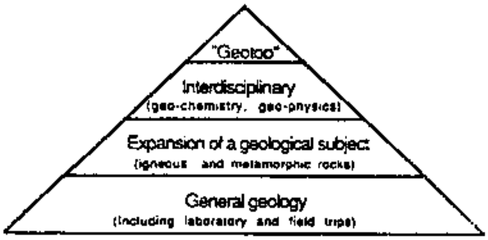

Figure 1 The conceptual framework of the geology curriculum.

1. The main general geology course at the base of this structure covers the basic geological topics and includes a laboratory and at least three one-day field trips. The development of the field trips, and their integration in the curriculum, will be expanded on later in this article.
2. The next stage focuses more closely on one of the topics that was taught at the first stage, such as *igneous and metamorphic rocks* (Orion et al. 1986).
3. The third stage focuses on one of the most important characteristics of geology as a scientific discipline - it's interdisciplinary nature. At this stage the student has to learn one of the following courses: geo-chemistry, geophysics or geo-biology.
4. At the top of the pyramid we have the 'Geotop', an individual research project in which the student utilises the previous courses, to conduct a mini research project in the field, in the laboratory, or both.

The educational field potential of Israel

In the curriculum we emphasise the use of field trips as a learning aid, as a means of concentration. In a relatively very small piece of land, Israel has a great variety of geological phenomena which are well exposed on the surface.

A distance of about 550 km from the gulf of Eilat in the south, to the Galilee in the north, the country can be divided into several geological terrains (Figure 2).

Figure 2 A fault line in Eilat region.

a) The southern part

The Eilat region: In this area the major rock types that form the Earth's crust can be seen: igneous, metamorphic and sedimentary (marine and continental). Additionally, this area represents clear fault structures, such as horsts and grabens, caused by the stress regime of the Rift-Valley that borders this area in the east. The reefs in the gulf of Eilat represent a recent marine geological environment.

The Negev region: This arid area is composed of sedimentary rocks that were folded into a series of asymmetric anticlines and synclines. The anticlines are characterised by a unique geomorphological phenomenon called Machtesh - a wide window to the depth of the anticline, excavated by erosional processes (Figure 3). The most interesting, Negev Machtesh-Ramon, was declared a Geological National Park. A visiting centre, sign-posted geological field trips and other facilities under development, have turned the Ramon into a geology learning field centre.

Figure 3 An aerial photo of Machtesh Hatira, central Negev.

b) The central region

A west-east cross-section through the central part of Israel, from the Mediterranean to the Dead Sea, passes through five geographical and geological strips (Figure 4).

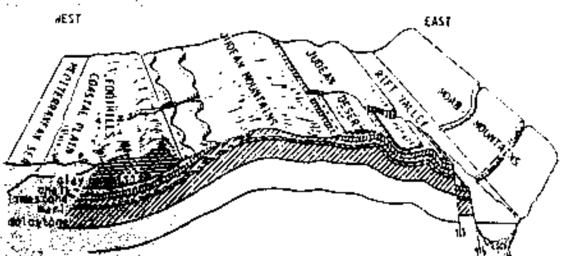

Figure 4 Cross section (west-east) through the central part of Israel.

The Coastal Plain: (Figure 5). this area consists of Pleistocene continental sediments, mainly calcareous sandstone (locally called kurkar) and quartz sand dunes. The exposures demonstrate continental processes such as wind sedimentation and soil formation.

Figure 5 The beach profile in the central part of the Coastal Plain.

The Foothills: This area is characterised by moderate hills of horizontal bedded chalk.

Figure 6 Stalactite cave in the Judean mountains.

Judean Mountains: The exposures in this area include marine sediments, mainly dolomite and limestone, as well as chalk, clay, marl, phosphorite, chert and porcellanite. The rock layers are folded to an anticlinorium structure. Karstic phenomena are common in this area (Figure 6).

Judean Desert: This area lies on the eastern flank of the anticline. It is characterised by secondary folds superimposed on the main structure. The synclinal exposures include a thick section of chalk, chert, bituminous chalk, phosphorite and high temperature metamorphic rocks. The difference in altitude between the Judean mountains and the Rift Valley causes an intensive erosion process. The rivers dig through the chalk and the hard limestone beneath and create canyons. In some of these canyons, karstic springs are exposed (Figure 7).

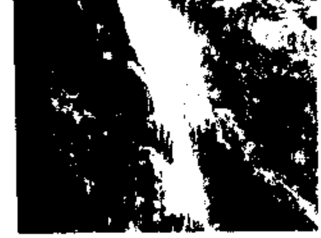

Figure 7 A spring in Ein-Gedi canyon, Judean Desert.

The Rift Valley: This is a long narrow valley, with the Dead Sea in it's deeper part (400m below sea level). The steep cliff forming the western border of the valley is a fault escarpment. The bottom of the valley is filled with continental sediments that represent a variety of environments: rivers, lakes and evaporitic sequences. The Dead Sea is an example of a recent evaporitic environment. Some of the exposures show mini-structures of normal faults, grabens and horsts (Figure 8).

Figure 8 Fault structures in young sediments of the Rift Valley.

c) The northern part

A west-east cross section through the northern part of Israel is similar to the central part, but not identical. The Galilee mountains in the central part of this area are composed of marine sedimentary rocks, formed in the same folding event that effected the Negev and the Judean mountains. Additionally this area is characterised by fault structures, basalt and other volcanic phenomena.

Geological field trips as a part of the curriculum

The use of field trips in the course *Igneous and Metamorphic Rocks - Eilat-Timna Region*, has been described previously (Orion et al. 1986). The results of the evaluation of it's implementation guided the development of the other learning field trips for the *General Geology* course.

As a basic course, *General Geology* deals with many concrete concepts such as bedding, rocks, soils, folds, faults and karstic phenomena. These concepts are concrete if they are learned by direct experience. Thus, field trips are an essential part of such a course.

a) Stages in the development of the field trips

The development of the field trips was subjected to three main criteria:

(i) *Administrative criterion* - The field trip should be easy to organise.

(ii)*Curricular criterion* - The field trip should cover basic concepts, that can be taught in the field by concrete activities.

(iii)*Educational criterion* - **The field trip should be** mainly a learning experience rather than a social event or adventure.

The west-east cross-section through the central part of Israel from the Mediterranean to the Dead Sea, can be used to satisfy these criteria. As far as administrative convenience is concerned, it passes close to the largest population centres of Israel, and is thus readily accessible. Also a one-day field trip is not difficult to organise, so the cross-section was divided into three full-day field trips. Each field trip has its own emphasis and can be used as a separate entity.

Field trip 1 - The Coastal Plain - deals with continental sedimentary rocks, continental processes such as wind transportation and sedimentation and the beach as a recent geological environment.

Field trip 2 - From the foothills to the mountains - deals with marine sedimentary rocks, fold structures, marine fossils, springs, karstic phenomena, geomorphology and the development of the Judean Mountains (from the Cenomanian to the Pleistocene).

Field trip 3 - From the mountains to the Rift Valley - deals mainly with marine and continental rocks, fault structures, mapping units, a karstic spring, economic geology, recent geological environments, geomorphology and the development of the Rift Valley.

Thus basic concepts covered by each field trip satisfy the curricular criterion.

The educational criterion was satisfied in two stages. First we developed the field trip as a package with learning and teaching aids. Secondly, we integrated the field trip into the curriculum.

b) Steps in the development of field trips

The process of developing field trips satisfying the three main criteria above, can be generalised as described in the following seven steps.

Step 1: Selection of the field trip area.

Step 2: Definition of duration. We preferred three one-day trips, but local conditions may favour fewer trips and of longer duration - for example if the travel time to the field trip area is relatively long.

Step 3: Geological map of the area for teaching purposes. Such a map should determine the educational potential of an exposure as a learning station. It should produce a list of exposures, described by the concepts that can be taught; that is, an educational inventory of the exposure. The educational potential of an exposure can be determined by two factors:

- the concepts that are (clearly) visible at the site:
- the learning conditions, such as the size of the exposure, the microclimate and the ease with which the site can be located.

Once such a map has been created it can serve as a base for different courses.

Step 4: Concept matching. The curriculum concepts are matched at this stage to the relevant items in the educational field inventory.

Step 5: Planning the route. The purpose of this step is to organise the learning stations in an order which satisfies the educational and administrative constraints.

Step 6: Development of learning aids. For example, the package we developed for each field trip included a field-trip booklet that directs the student's work at each learning station, a series of mini-posters to help the teacher explain some of the geological observations and a teacher's guide.

Step 7: Placing the field trip in the course structure. This involves determining what will be taught before the field trip and what will follow.

The use of the field trip as a concretisation tool, is a learning strategy similar to the learning cycle suggested by Karplus and Lawson (1974). this strategy places the field trip early in the learning process. Before the field trip there is a short preparatory unit that includes other concrete activities to prepare the students for the activity, whereas the main traditional learning component takes place afterwards. Thus the early concrete stages help the students deal with the more abstract parts of the curriculum.

c) Implementation and evaluation of the field trips

Since the population of the geology high school students in Israel is still very small, few of geology oriented geography teachers were selected to implement the field trips. They attended an in-service training course of 120 hours, during the school holidays. The field trips were implemented experimentally during the last two years (1987/1988). In all, more than 1,000 students (grade 9-12th, ages 14-18), from about twenty-five classes in twelve different high schools, took part in one or more of the field trips.

Formative evaluation of the learning materials and an investigation of the factors that influence student learning processes in the field, included student attitude and knowledge questionnaires before and after the field trip and observation of student behaviour during the field trip. The data are still being analysed and we expect that the results will provide useful information about outdoor environmental learning processes.

Summary

Field trips should be an important component of any geology curriculum. The local conditions in Israel enable the wide use of this learning aid, but it's proper use requires both educational and logistical planning. The method described integrates the educational field inventory with the demands of administration, the curriculum and with factors that influence learning ability in an outdoor environment.

The qualitative data obtained by the observers indicates that, where teachers followed our instructions consistently, the field trip was a successful learning event. This finding will be investigated by detailed analysis of the quantitative data.

The learning through geological field trips can be considered as the exploitation of a natural resource by the Israeli educational system. We would be prepared to offer this resource to teachers and students in other countries that do not possess such a readily available rich geological environment.

References

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