3. Paleomagnetic data presented here partly coincide with Morner and Sylwan's scheme (1987) for the Lago Buenos Aires moraines (46 30S, 71 30W). They identified five moraine zones: Only the two internal moraine zones showed normal polarity; the two external ones belong to the reverse Matuyama Epoch; and the intermediate moraine zone remains uncertain.

## REFERENCES


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| Moraine Group | Samples | D | I | K | $A_{95}$ |
|---|---|---|---|---|---|
| IV | 7 | 340.0 | -53.9 | 22.9 | 12.9 |
| III | 5 | 324.6 | -55.5 | 36.2 | 12.9 |
| II | 5 | 327.5 | -46.3 | 42.7 | 11.8 |
| I | 11 | 351.7 | -47.4 | 45.3 | 6.9 |

**Table 1—SRM directional values after AF and thermal demagnetization.**

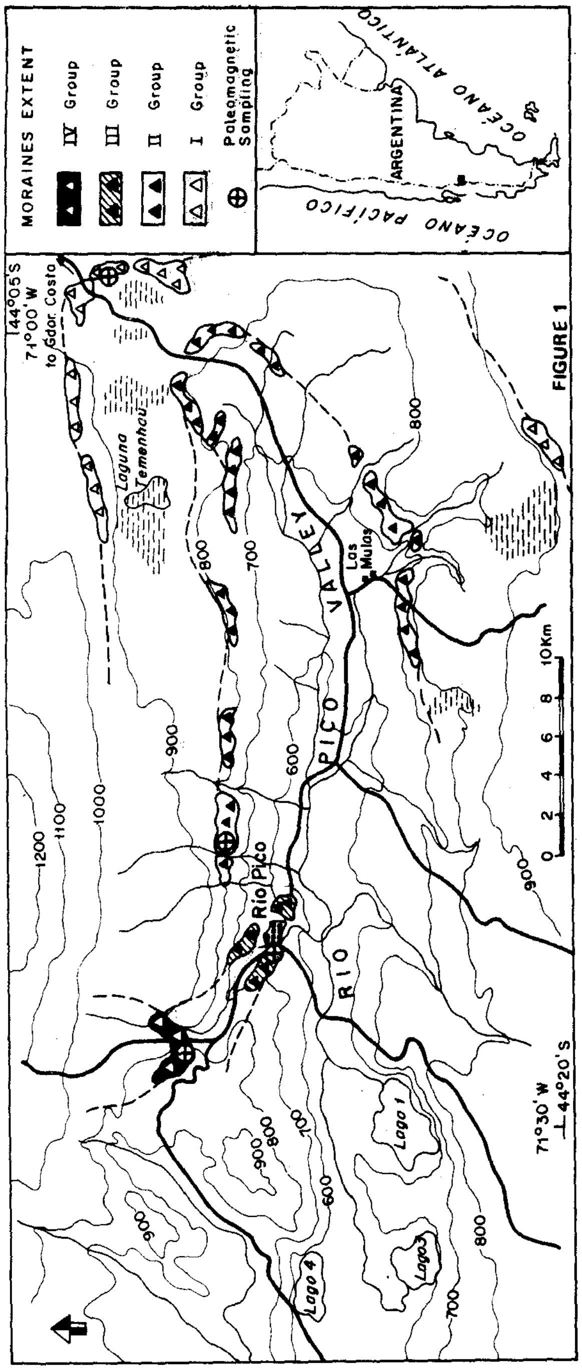


**Figure 1—Distinguished moraine groups at Rio Pico Valley and paleomagnetic sampling sites. Topographic base of IGM.**

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Tectonic Evolution of Iranian Mountain Belts

The crust of the Iranian plateau is an agglomeration of different continental fragments that separated from the Gondwanian Passive margin, traveled hundreds to thousands of kilometers, and accreted to the margins of Laurasia/Eurasia during different collisional orogenies. Tectonic evolution of the Iranian mountain belts may be divided into two main phases, namely Pretethyan (late Proterozoic to Permian) and Tethyan (Permian to Present). The Pretethyan evolution was governed by (1) late Proterzoic-earliest Paleozoic Pan-African orogeny, (2) the Caledonian, and (3) the Hercynian movements. The Tethyan evolution took place during two partly overlapping events in time: (1) the Paleotethyan (Permian to Jurassic), and (2) the Neotethyan (Jurassic to the Present).

The late Proterozoic-earliest Paleozoic Pan-African orogeny was followed by a widespread rifting phase over the entire area. During the Paleozoic era, the whole region was a relatively stable continental platform with epicontinental shelf deposits that lacked magmatism or folding. The Paleozoic quiet platform condition was disturbed by the widespread late Emsian-Eifelian (regression during the Caledonian movements?) and the late Carboniferous (regression during the Hercynian movements?) hiatus. Possible Silurian-Devonian clockwise rotation and northward movement of Central Iran, and the Carboniferous-Permian southerly movement of Central Iran, could perhaps account for these epeirogenic movements. The intra-Permian southerly movement, or the Permian-Triassic northerly movement of Central Iran could perhaps account for the metamorphism of the Silurian-Devonian rocks of the Sanandaj-Sirjan belt, resulting in the closure of a small intra-Gondwanian (ocean) basin.

The Paleotethyan evolution was governed by the main north-dipping (present geographic orientation) subduction zone of the Paleotethyan oceanic crust beneath southern Laurasia during the Permian-Triassic interval. Two segments of the Paleotethyan suture belt are discovered in northeast and northwest Iran: (1) the Boghrov Dagh-Talesh-Lahijan, and (2) the Mashhad nappes.

The entire imbricate packages of the Boghrov Dagh-Talesh-Lahijan and the Mashhad are thrust southwards onto the rocks of the Alborz and Central Iranian platform (ranging from Cambrian to Middle Triassic). The entire deformed ensemble at both regions, together with the Paleotethyan foreland and hinterland, are in turn unconformably overlain by the Rhaetic-Liassic Shemshak Formation. Therefore, the Paleotethys must have closed along the Talesh-Khazar (South Caspian)-Mashhad line sometime during the Early Triassic to Liassic interval.

The northward motion of the Central Iranian continental fragment(s) was responsible for (1) the main north-dipping subduction zone of Paleotethys beneath Laurasia, (2) the closure of the Paleotethys along the Talesh-Khazar-Mashhad line in northern Central Iran, and (3) the apparently simultaneous opening of the Neotethys in the south, with at least two branches, the Qaradagh-Sabzevar in the north and the Zagros in the south. During this time, Central Iran internally disintegrated and gave birth to the intra-Central Iranian narrow oceans. The initial Neotethyan rifting commenced during the Permian and is indicated by the switch from the generally quiet platform detritics to open marine sedimentation, and facies-thickness changes across normal faults. The Neotethyan ocean opening in the Iranian foreland took place largely during the late Triassic-early Jurassic period.

The Qaradagh-Sabzevar ocean in the north separated the Central Iranian platform from the Alborz-Binalud (southern Eurasia), whereas the Zagros ocean in the south separated the former from the Gondwanian foreland (the present Zagros belt). Both the Qaradagh-Sabzevar and the Zagros Oceans were eliminated mainly by the north-northeast-dipping subduction beneath Caucasus-Binalud and Central Iran, respectively. Subduction of the Sabzevar ocean beneath Binalud formed the Joghatay-Neyshabur-Mashhad Andean-type magmatic-arc together with the Kopeh



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Dagh marginal basin (without ophiolite) during medial Jurassic to Cretaceous. Subduction of the Zagros ocean beneath Central Iran formed the Alvand–Bazman Andean-type magmatic-arc along the Sanandaj–Sirjan belt, and the Nain–Baft–Inner Makran marginal basin (with ophiolites) during Jurassic to Paleocene.

Apparently the contraction of the oceans began during the late Cretaceous–Paleocene when widespread ophiolite nappes were emplaced onto the (1) Sevan–Akera–Qaradagh–Sabzevar, (2) Nain–Baft–Inner Makran, (3) southern Makran, (4) Sanandaj–Sirjan, and (5) High Zagros–Oman.

The middle Eocene collision of the Lut and the Afghan blocks in eastern Central Iran resulted in widespread ophiolite emplacement, west vergent imbrication, and folding of the East Iranian flysch along the Sistan suture zone. During the Paleogene synchronous Andean-arc and back-arc spreading stages were developed above the subduction zone of the Zagros ocean in Central Iran. This is characterized by calcalkaline magmatism along the Karkas–Jebal Barez and alkali basalt volcanism in northwestern and northern Iran. Apparently the intraplate block faulting and predominately alkali basaltic volcanism (back-arc spreading stage above the Zagros subduction zone) led to the formation of two marginal basin complexes: (1) the South Caspian marginal basin in the north (with oceanic crust), and (2) the Oligocene–Miocene Lower Red-Qom Formation back-arc/inter-arc basin in northern Central Iran (without oceanic crust).

The terminal collision of the Zagros with Central Iran took place during Pliocene and created the present compressional tectonic regime of the Iranian mountain belts. Continued east-northeast convergence of the continental blocks resulted in thickening and shortening of continental crust by active folding, reverse faulting, elevation of the Iranian fold-thrust mountain belts, and subsidence of the intermountainous compressional depressions.

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## Computer Modeling of Some Aspects of Post-Sarmatian Sedimentary Basin Evolution of Great Hungarian Plain

The research of the accumulation of sedimentary basins on the scale of megasedimentology means solving the following two main tasks: (1) revealing and mapping of the rock bodies developed in the same depositional environment; and (2) revealing and mapping of the prograding cycle of the basin accumulation.

In the Hungarian Hydrocarbon Institute a computer system has been developed to realize these tasks for the subsurface Post-Sarmatian clastic formations of the Great Hungarian Plain.

The Post-Sarmatian clastic rocks of this basin have been classified into some formations (lithostratigraphic units) on the basis of their general sedimentological characters. Some of these formations have been developed under the effects of some delta megacycles filling up the basin.

The basic principle of this computer system is that within a given regional environment the exogene forces form a rock body morphology that may be characteristic for the given type of environment. Obviously, this is the basis of seismic stratigraphic interpretations, too. Five independent spatial parameters have been chosen to describe the subsurface position of a clastic formation in a borehole. These parameters are regarded to be the components of the vectors describing the subsurface position and morphology of a chosen formation. Now, according to the mentioned principle, the vectors representing a rock body that has been formed by the exogene forces in the same way may be expected to group in the sample space. It can also be expected that the elements of these groups will be arranged according to the natural differences of the given morphology. So the investigation of the areal distribution of the rock bodies formed by the same exogene forces is possible by using a Q-mode cluster analysis of the sample space. The dendogram will show the morphological hierarchy of the studied formations. On the dendogram, the clusters are defined by dismantling the dendogram downward until they are mappable (this is an interactive way, and the geologist can modify his work-hypothesis as much as he wants). The mappable end clusters are regarded to be morphogenetic units.

Because of the above-detailed construction, the results closely connect the morphological position of the Neogene basement and morphological evolution of the rock bodies underlying the formation analyzed. That is, each morphogenetic unit contains rock bodies of the same part of a regional environment including effects of tectonics and the compaction shape deformation.

Consequently, these morphogenetic units have to be regarded as the results of independent processes, which can be recognized by an R-mode factor analysis of the tested spatial parameters. The factors are traced back to independent sedimentological or geomorphological processes. Generally, more than one independent process can influence the given characteristic of a rock body. This fact is expressed by the appearance of some parameters in more than one factor. In this way, the morphogenetic system of each formation can be identified and mapped. Because of the lateral repetition of a delta plain morphologic unit showing fast accumulation and redeposition, three main prograding units can be listed as probable in the Post-Sarmatian basin accumulation. The contact between the rock bodies belonging to these three prograding delta plain successions on the surface of the delta plain formation may be regarded to be the projection of the time horizon of a prograding system.

On the basis of Walter's facies law, the time horizons can be identified with the most probable settlement succession of the different morphogenetic units belonging to one of the three prograding cycles. The method of this step is the "embedded" Markovian chain analysis. The areal distribution of the coexisting morphogenetic units chosen by the Markovian chains can also be mapped along their time horizon from the center toward the edges. In this way, a movie-like map series can be given about the temporal change of the basin-filling processes as well as the temporal development of the rock bodies and their regional environments.

The entropy set is used to indicate the degree of the random occurrence in a multicomponent system. In the present study, the methods of calculation suggested by Hattori (1976) were used for the "embedded" Markov matrix of the eight tested formations. So, two types of entropies pertain to every formation. One is relevant to the Markov matrix expressing the upward transitions, and the other is relevant to those expressing the downward transitions. The first type is the entropy after the deposition of the whole formation rock body, while the second one is the entropy before the deposition of the whole formation body. The basic principles of the interpretation are as follows: (1) These rock bodies express the evolution of the filling-up mechanism on the basinal scale; that is, these processes cannot be independent from the background Carpatians; and (2) on the basis of the general environmental interpretation, the formations can be expected to separate at least into two groups in a coordinate system expressing somehow the tectonic background of this filling-up mechanism. The validity of these expectations has been proved and the studied filling-up mechanism can be connected to two great tectonic phases of the Carpatians; namely, the Attic and Rhodanian tectonic phases.

During the last few years seismic stratigraphic analyses have proved the existence of the regional environments suggested by this system (e.g., the joint OKGT–USGS cooperative investigation of the Bekes Basin, southeast Hungary).

The computer background of this system is the "SZEGED" program pack. It runs on IBM-XT/AT.

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## Periodotite Inclusions in Basalts of Persányi Mountains, Transylvania Roumania

On the basis of the correct descriptions of mineral components of different geological sites in the book Erdély Ásványainak Kritikai Átnézete (Critical Review of Minerals from Transylvania) by Antal Koch, Kolozsvár, 1885, it has been possible to identify the basalts of the Persányi Mountains as host rocks of different mafic and ultramafic xenolith inclusions.

Introduction: There are about 200 places all over the world where alkalic basalt volcanism has delivered periodotites and other related mafic derivates as xenolith inclusions from the upper mantle and lower crust regions to the surface of the Earth (Forbes and Kuno, 1967). The mineral assemblages of periodotites are not in equilibrium with the host basalts in which they are embedded, and during the last three decades the periodotite xenolith inclusions containing basalts became important sources for mantle petrology because these are the most widely distributed test places where mantle rocks can be detected (Green and Ringwood, 1967). In measuring mantle-crust processes, inclusions from any new sites may have individual features in addition to the general similarities of periodotites and their derivates.

Both because of old traditions in mining since medieval times and because of wealthy and variable rocks and tectonic setting, Hungarian geology was among the most developed surveys in Europe during the Austro-Hungarian Monanchy. The most outstanding scientific achievement of eighteenth century Hungarian geology was the discovery of the Tellur, in Transylvanian Gold-Tellur ore minerals. On the level of world geology, most important information was collected and published in the last century. On the basis of one of these collections, which treats the minerals of a historical region of Hungary, I should like to call the attention of interested geologists to a probable source region of periodotite inclusions and some derivates in Transylvania. These periodotite-containing basalts can be found in the Persányi Mountains, 50 km northwest of Brassó (Brasov). The collection that has preserved information about these sources is