Geomorphological Cartography, applying Remote Sensing, GIS and GPS technology.

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1. Abstract

This paper demonstrates the use of modern tools, such as GIS and GPS, in geomorphological cartography, as well as the benefits of this combination. By using such systems, not only do we increase the calculation speed and the accuracy, but we also make the further evaluation of the primary results and data easier.

This computerised method has been applied on Paros island (Cyclades), and the results were cross-tested via field work, pointing out the accuracy and the efficiency of the method.

2. K-words

- G.I.S.
- G.P.S.
- Geomorphology
- Cartography

3. Purpose of the study – Selection of the working area

This paper describes a methodology on geomorphological cartography, with the use of modern tools. This study has been applied to Paros island (Cyclades). Paros was selected among other Greek places, because of its high density on geomorphological and lithological characteristics. The maps that will be presented in this paper, cover the North-Eastern part of the island, that gathers most of the geomorphological elements that were mapped on the full island survey (Figure 1).

4. Methodology of collecting and inputing data in the GIS database.

The data that we digitized into the GIS (Geographical Information System) MapInfo, were deriving from primary information sources and their secondary process. In some cases, the comparison of two separate information layers was nessecary to isolate and correct errors. The primary sources that were used are:

- Bibliography
- Geological Map-Scale 1:50.000, (Institute of Geology and Mineral Exploration,1996)
- Topographic Maps-Scale 1:50.000, (Geographical Military Service, 1972)
- Aerial Photos (Scale 1:30.000), (Geographical Military Service, 1988)
- Field survay, measurments.

The digitization of the above data, enriched by the secondary information, resulted in various GIS layers.

Field work was significantly helped by the use of the GPS (Global Positioning System), connected to the GIS software of a portable computer. This combination is a very powerfull tool providing to the geologist the ability to instantly input the field observations into the digital database. This technique offers two very importand advantages: the continuous observation of the geologist's field position, and the indication of new interesting spots. The collected data are cross tested with the existing data (coming from maps and aerial photos). The more complex layers should be placed under the more simple ones.

Following the above concept, we created the map of figure 2. This map includes the two-dimensional data (surface data), and has information in separate layers concerning lithology, flattish forms, karstic planes, strand plains, relict forms, and telus cones.

The next step was the addition of linear and point data. As previously described the dot elements are placed at the upper layers, above the linear ones (figure 3). The linear data demonstrate the drainage system, the primary and secondary road network, the tectonic lines (faults, folds), and the coastline morphology, while the dot elements towns, villages, tobolo, terraces, quarries and various shapes of the valleys.

The final geomorphological map (figure 4), is the result of the superimposition of the two previous maps. The legend of the geomorphological map is shown in figure 5. In case the final map, is too complicated the user has the ability to selectively hide information layers, zoom in and zoom out, and produce different maps suitable for certain purposes. This map enables the user to select and update data from one or more layers, make complicated searching, measure and correlate information of one or more layers. Moreover, GIS provides tools for statistical or quantitative analysis, spatial distribution and for exporting data to external software equiped with specialised analysis tools.

Each object on the digital map is not only a graphical visualization, but it is also connected to an internal or external database with various fields. This enables the statistical and quantitative measurments, and the expression of the results in the form of grouping tables, browsers and charts.

For example we present a statistical analysis of the drainage system. The following table displays the count and length of drainage system related to the lithological units. This statistical analysis, points out that this part of the island has an extensive development of the drainage system over the gneiss-schists, maily due to the nature of this formation. The rest of the lithology sequence, respectively to the drainge system is Carbonates, Quaternariew and Igneus rocks.

Table 1.					
Lithology		**V Shaped Valley**	**U Shaped Valley**	**X Shaped Valley**	**Total ‘V – U - X - streams’**
Quaternary	Count	1	9	2	15
	Sum (m)	0,4636	111,1210	235,9190	150,2440
	Avg (m)	0,4636	123,4670	117,9590	100,1630
	Min (m)	0,4636	0,1896	0,2527	0,0717
	Max (m)	0,4636	243,5910	210,6440	243,5910
Carbonate	Count	1	2	0	12
	Sum (m)	154,3350	123,1290	0	926,2380
	Avg (m)	154,3350	0,6156	0	0,7718
	Min (m)	154,3350	0,5633	0	0,4629
	Max (m)	154,3350	0,6679	0	154,3350
Gneiss-Schist	Count	0	10	1	25
	Sum (m)	0	83,0020	314,2990	193,7230
	Avg (m)	0	0,8300	314,2990	0,7749
	Min (m)	0	0,1809	314,2990	0,1199
	Max (m)	0	249,4480	314,2990	314,2990
Igneus	Count	0	9	0	13
	Sum (m)	0	643,1540	0	868,5580
	Avg (m)	0	0,7146	0	0,6681
	Min (m)	0	0,1719	0	0,1719
	Max (m)	0	121,1360	0	121,1360

5. Conclusions

GIS is not only a tool for coding, storing and retrieving data related to the surface of the earth, but with a full database support, internally or externally, presents a modelization of the real world. The user has the ability to instantly modify and process the data fast and accurately.

In this way, GIS can be used to produce a theoretical modeling of the studied area describing environmental processes and possible consiquenses of an environmental planning. This modeling, can be applied to a series of different possible scenarios, to help the understanding of the consiquences of certain decisions, before they occur and produce irreversible damage to the environment.

It is obvious that GIS has a lot to offer in geomorphological cartography not only on the map construction but on the processing of data that are contained in the map. Every graphical form being in the map is accompanied with information.

The main advantages of GIS in this kind of application are:

- Very fast creation / update / layout modification of maps.
- Cheap production and reproduction of maps, even in a very small number of copies.
- The ability of experimenting on different representation layouts of the database.
- The easy combination or selective visualization of different information layers and objects within a layer.
- Reduces the need of use traditional maps, preserving the data in a digital form, ready to be used or modified at any moment.
- Performs the statistical and quantitative analysis of data (either from map or database).
- Enables the production of output that is difficult to be produced by hand, like 3-D and stereoscopic maps.
- Enables very high accuracy, due to the digital form of inputing and updating.
- Enables the simultaneous use of other equipment, like GPS and portable computers, maximizing accuracy and efficiency, even during field work.

6. Bibliography

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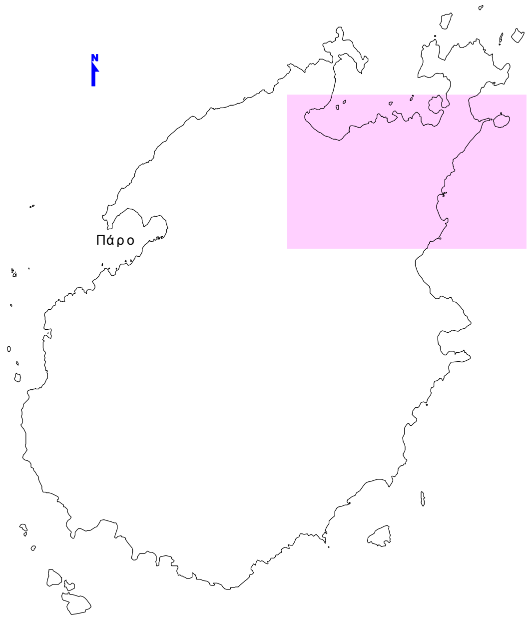

Figure 1: The Northeastern part of Paros island that is shown in the following maps of this study

Figure 2: Surface data

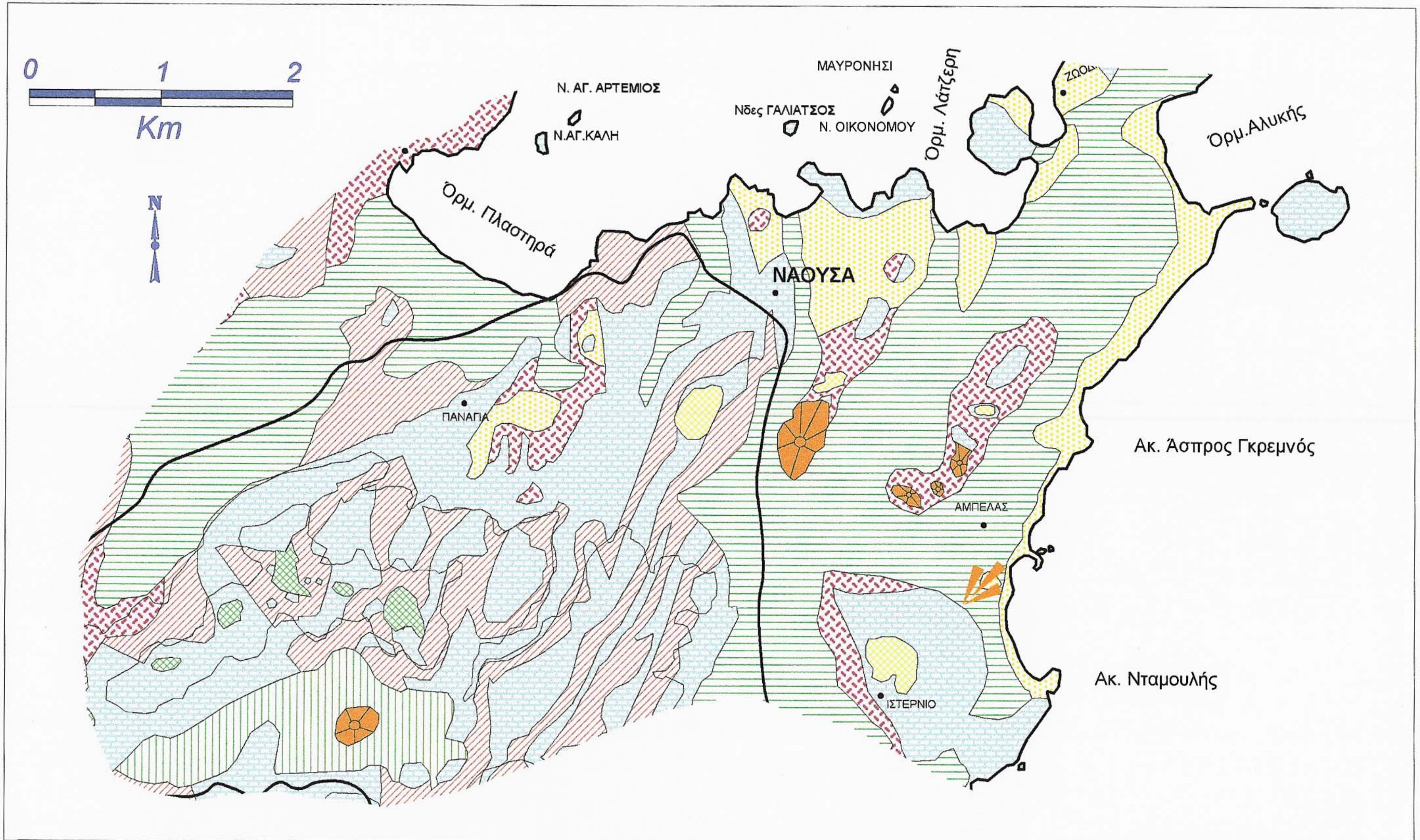

Figure 3: Linear and dot data

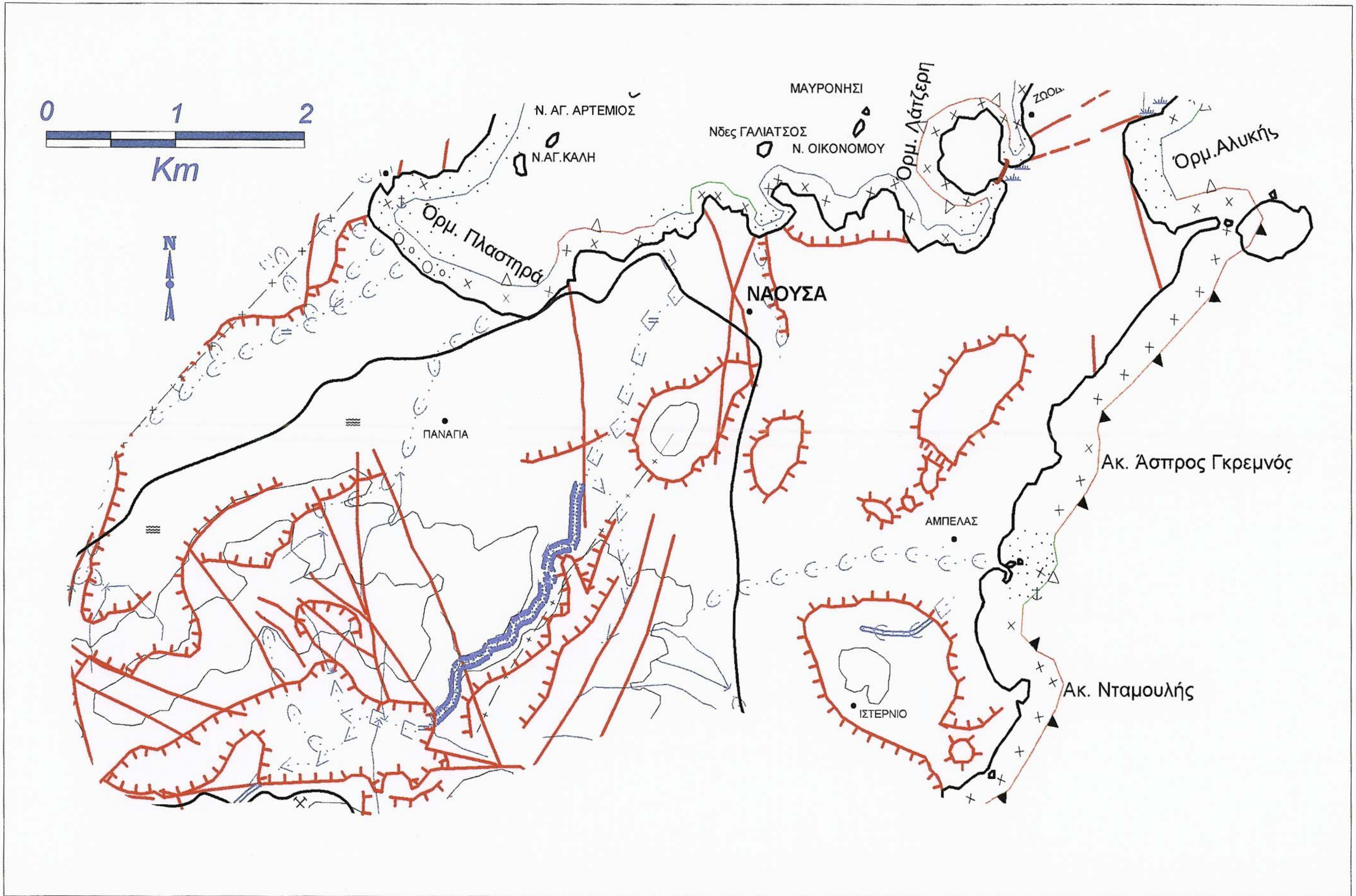

Figure 4 : Geomorphological map of Northeastern part of Paros island

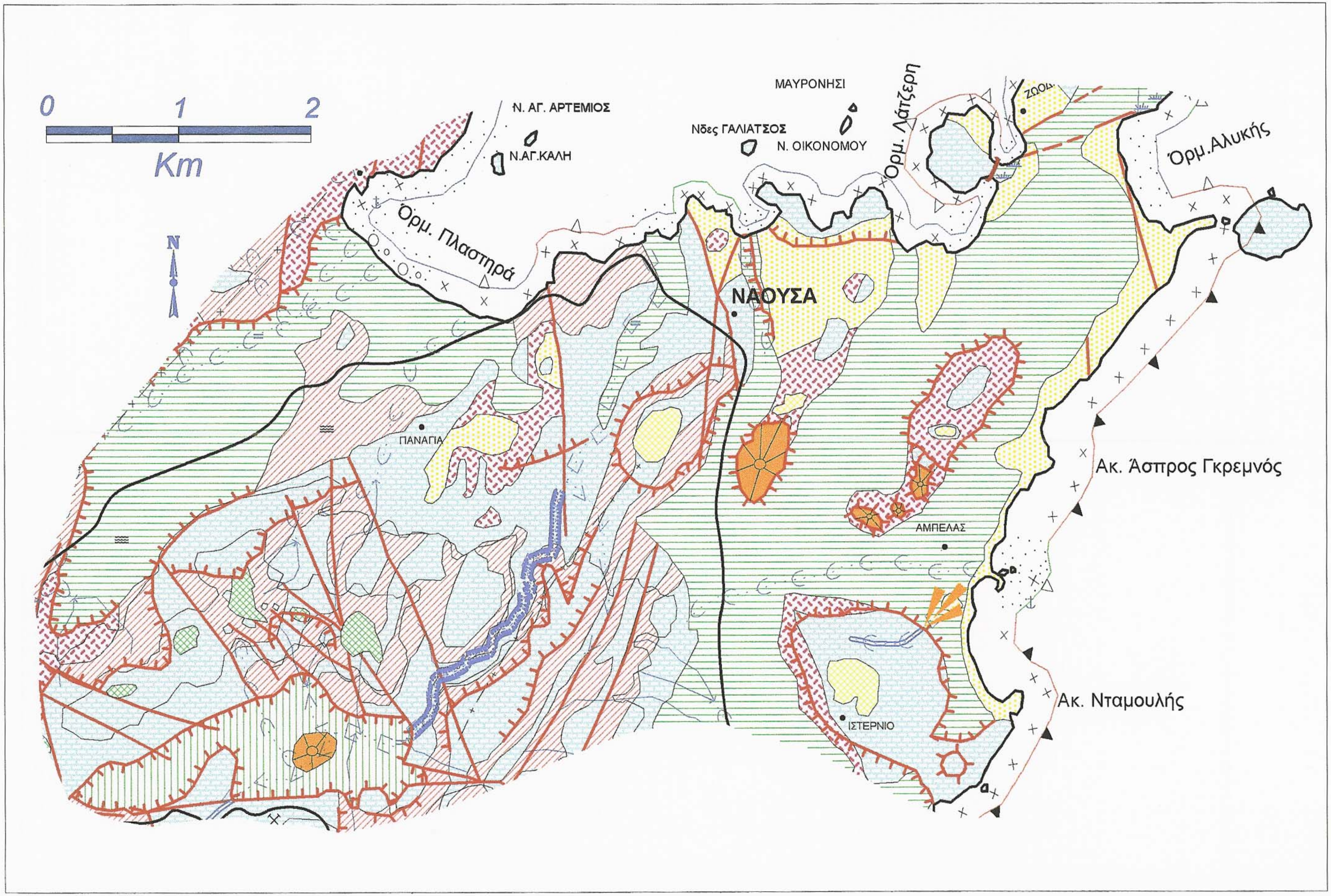

Figure 5: LEGEND OF THE GEOMORPHOLOGICAL MAP OF PAROS ISLAND (CYCLADES)

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