

## GEOLOGICAL AND GEOMORPHOLOGICAL CARTOGRAPHY AT SCALE 1:10.000 : A TOOL OF MANAGEMENT FOR TOWNS

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### Abstract

Geological and geomorphological mapping at scale 1:10.000 besides from being an important source of scientific information it is also a necessary tool for municipal organs in order to make proper decisions when dealing with geo-environmental problems concerning integral territorial development. In this work, detailed information is given on the contents of such maps, their social and economical application, and a balance of the investment and gains that derives from them.

### 1 Introduction

It is out of all doubt that mapping is an essential tool for territorial development. The geological and geomorphological information they contain contribute greatly to the establishing of a primary database of obvious scientific utility; though it may, at times, be difficult for non specialised people to appreciate the immediate utility of having such information. Often it is other interpretative readings brought about from different social and economical points of view that provide such maps with an added value to the geological data, because of their utility in solving environmental, urban and resource exploitation problems, to mention some of the most important ones.

Often, municipal government has to confront such problems for the solving of which a precise notion of the environment is necessary. But geological and geomorphological information that most town councils have derives of that which is contained in the several maps published by official regional or state institutions. Since such maps are of a very small scale given the great extension of the covered area, data represented on them is very general, with very few differentiated materials and, sometimes, imprecise boundaries. For this reason, municipal institutions often ignore the geological traits of their territory and this prevents them from facing, with full guarantees, the making of decisions when confronted with such situations.

The Geological Unit of the Universitat de Girona has published, since 1978 up to the present date, 36 geological and geomorphological maps of different sectors of the province of Girona. Of these, 18 are detailed cartography of different municipal boundaries at scale 1:10.000 and 1:5.000 [1]. This task has allowed the team of investigators involved in it to acquire experience in working methodology and in map editing, as well as it has allowed them to verify the operability of the resulting cartographic material.

### 2 Scientific information in geological and geomorphological maps

Geological maps are, in essence, the graphic representation of geological information of a part of the Earth surface. They are the result of projecting upon a specific base -usually a topographic map-, the distribution, composition and structure of outcrop rocks. Its reading allows an easy identification of the several lithologic units, the structures that affect them and the presumed age of both. Even though the data they contain represents only the ground's upper part, from it one can extrapolate the display, at a greater depth, of different materials and structures.

Geological maps give precise information on:

### The features of the rocks represented on them

Precise knowledge of parameters such as mineralogical composition, texture, degree of surface alteration, porosity, density, orientation and width of cracks, among other things, is essential for posterior application in specific situations .

### Three-dimensional geometry of geological formations

Information on orientation and limits of outcrop rocks, as well as on orientation of structures that affect them allow the obtaining the depth and volume of geological formations.

### Age of rocks and structures

Geology, being an historical science, pursues temporal sequentiation of the elements of its study. Geological mapping allows the establishment of an order in materials and geological structures which is based on the different existing relative and absolute dating methods .

### Geological processes

Rocks and structures have been generated through processes, either internal or external, that can be interpreted.

Geomorphological maps represent those landforms that have resulted from geodynamical processes and often they include surface formations. Unlike geological maps, they don't allow much of an extrapolation on of data. They give information about the age of the represented landforms and on their relationship with the processes that have generated them. Notion of age and genesis of these landforms allows to deduce which were the active processes they underwent and, thus, to predict their possible future effects.

## **3 Social and economic use of geological and geomorphological maps.**

Geological and geomorphological cartography at scale 1:10.000 gives sufficient degree of detail and contains information precise enough to allow the extraction of interpretative readings applicable to the solving of many social and economic problems.

Among the most obvious uses we have got :

### Obtaining geotechnical data

Information on physical and geometrical features of an area's geological formations is obtained by means of a specialised analysis. In this way, geotechnical data is obtained concerning the composition of materials, degree of consolidation or of mechanical behaviour, continuity or discontinuity of materials and structures and stability of the ground, among other things. All these variables are of inestimable value in urban development, architecture or engineering.

### Identification of active geological processes and recognising of signs associated to them

Cartographic identification and delimiting of active geological processes of a certain territory allows to evaluate the likelihood of their occurrence and which areas may be affected. Among the several geological risks stand out, -because of their catastrophic effects and of the great extent of damage-, quakes, floods and vulcanism. In a lesser degree, of affectation we've got risks of rock sliding and ground movement, collapse sinking, expansive lands, among others. All of these are of an enormous social and economical effect. Geological and

geomorphological data must necessarily contribute in the making of decisions concerning urban qualification, territorial development, evacuation planning, value of the ground, among other things.

#### Evaluation of natural resources

Geological useful and geomorphological cartography gives precise information for identifying and locating great part of the natural resources of a given territory. Data contained in these maps give us information about the availability of such resources and facilitate projects of conservation, protection or exploitation of geological materials for industrial or building purposes. Also about geoennergetic sources and about hydraulic resources of the area.

#### Determining the degree of potential vulnerability

Geological and geomorphological traits represented in these maps define superficies and interior display of materials and structures and also delimit the diverse morphodynamical units. From the information obtained by integrating different variables -geotechnical properties, porosity, permeability, transmissivity, geological risks, among others- it is possible to obtain correct interpretation in order to evaluate the ground's vulnerability to contamination and possible effect of natural resources. Location of potential contaminating activities such as residue dumps, service stations, industry and graveyards often requires objective scientific criteria in order to determine its suitability.

#### Identification and cataloguing of sites of geological and geomorphological interest

Geological and geomorphological cartography gives unique opportunities for documental gathering of those natural elements of special relevance that require, because of it, specific identifying and protection. Geological and geomorphological points of interest represent territorial plots or isolated elements that, because of their content, singularity of significance level, must be considered patrimony of common interest. Usually their relevance fall upon their scientific, educational or landscape interest. In any given territorial unit, it is necessary to know, survey and if necessary, protect and manage these sites.

#### Attribution of utilities for the locating of activities

With the confluence of all the above mentioned applications of geological and geomorphological detailed cartography we come up with a new function: integration of geological variables together with the rest of determinant factors of planification. This considerably enriches the correct attribution of territorial uses. Contribution of geological and geomorphological maps in the taking of territorial development decisions is especially important.

#### Scientific territorial knowledge

From a wider point of view, geological and geomorphological mapping, in itself, represents, in a more strict sense, an advance in scientific knowledge. Geological and geomorphological maps give data of great utility for future studies in numerous disciplines. They also provide a background of proved educational functionality and, in short, they contribute to the enrichment of the geographic information systems data bases.

It is obvious tot point out that geological and geomorphological mapping provides different kinds of information. Naturally maximum level of functionality is acquired with the existence of both of them and through interpreting them correctly. It is also important to point out that the utility of 1:10.000 maps increases in direct relation to the number of features mapped, to the

scale used in obtaining data and to the rigour and objectivity with which the different parameters have been selected.

Direct or indirect users of this kind of cartography include a wide range of professions such as urban and environmental managers, geographers, architects, environmental consultants, technicians in several administrations, constructors, well drillers, teachers, biologists, historians and archaeologists as well as politicians and impresarios of all kinds that may require knowledge of the physical environment in order to plan their activities.

#### **4 Profitability of geological and geomorphological maps**

Production of geological and geomorphological detailed cartography is an enterprise that should be evaluated in the terms of economical balance in which expenses and benefits of the investments must be contrasted. Numerous surveys answer for the profitability of such kind of cartography [2].

The cost of geological cartography at any scale can vary considerably depending on several parameters. Generally budgets include an amount destined to the obtaining of data and to the drawing out of the original cartographical material and another part is destined to its publication.

The factors that determine the cost of data obtaining are:

##### Characteristics of the area that must be mapped

The total surface, irregularity, accessibility and geological complexity of the land determine the duration of field work and thus the cost of the map.

##### Characteristics of the scientific team

The experience of geologists and the proximity of the studied area also affect the cost of the map and they reduce the duration of field work. Also, if the scientific team has proper geophysical, drilling, sample preparation and analyzing equipments, it becomes unnecessary to spend money in renting them. In general terms, working equipment of universities, geological services and investigation institutions is sufficient to deal with cartographic projects at better competitiveness conditions than private enterprises, making profitable, in this way, their function of public services.

Expenses deriving from map publishing are determined by their delineation, printing and distributing. For budget estimation one must consider the number, size, and chromatic complexity of the samples to be edited.

Considerable economical benefits are derived from geological and geomorphological mapping, in relation, mainly with territorial management and with the preventing of natural risks, aspects which have been dealt with before. Concerning prevention and responsibility of the territorial manager, it is obvious that the effects that some geological processes may cause on infrastructures and people mean a much greater cost than the investing expense in the production of preventive cartography.

Information contained in geological and geomorphological maps facilitates the carrying out of further studies of a much more concrete application. In this way the cost of the latter diminishes greatly. In the same sense, the non existence of these sort of maps implies that, when confronting any new situation related to the geological means, a new specific survey must be carried out and this implies the financing of several research projects of non reusable information.

For all what has been explained, geological and geomorphological cartography is an essential base for rational management of the environment, from which not only economical but also cultural, social and environmental benefits derive. All this makes these maps a profitable investment in municipal ambit.

### References

[1] Geological maps of Sant Feliu de Guíxols (1978), Castell-Platja d'Aro (1980), Girona (1982), Cassà de la Selva (1982), Maçanet de la Selva (1983), Santa Cristina d'Aro (1985), Palamós (1987), Palafrugell (1990), Begur (1991), Tossa de Mar (1991), Regencós (1991), Calonge (1992), Pals (1992), Mont-ras (1992) and Santa Coloma de Farners (1993); geomorphological maps of Palamós (1987), Tossa de Mar (1993) and Santa Coloma de Farners (1994).

[2] Bernknopf, R.L.; Brookshire, D.S.; Soller, D.R.; Mckee, M.J.; Sutter, J.F; Matti, J.C.; Campbell, R.H. , 1993. "Societal Value of Geologic Maps". U.S. Geological Survey Circular, 1111, 53p.