ARCHAEOLOGICAL GEOLOGY IN GREVENA, NORTHERN GREECE

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The main purpose of the 1993 Keck project in Greece was to learn more about the geomorphology and archaeology of the province of Grevena, Greece. Since 1987, I have been working with the Grevena Project, an interdisciplinary archaeological surface survey of the nomos (province) of Grevena, located in northwest Greece, near the borders of Albania and Yugoslavia (fig. 1). This survey is the first systematic archaeological study of the nomos. It does not include any excavations. The aims of our survey are to determine the times of human occupation in this area, the extent of the occupation and, as far as we are able, to reconstruct the natural and social environments at the times of occupation. More than 350 archaeological sites have been located in Grevena during the survey. The sites range in age from Early Neolithic through to Ottoman (fig. 2). We have also found Paleolithic artifacts in several places. There is thus a long history of occupation in Grevena, with settlement sites dating back at least 8000 years.

The geologic work on the project aims to discover the timing and causes of landscape change in the Holocene and to evaluate the natural resources during periods of occupation. In past years, we have mapped several archaeological sites in detail, completed geophysical surveys of several important sites, analyzed the sources of rock and ceramic artifacts, and analyzed regional patterns of soils and geomorphology, especially as related to agricultural potential and possible human effects on the landscape in the Holocene. The studies conducted by the students in the 1993 Keck program shed new light on the Quaternary history and archaeology of four important sites as well as on some significant problems in archaeological geology. Rob Sternberg, Franklin and Marshall College, was an equal partner in directing student projects and handling logistics, especially doing all the driving.

THE NATURAL ENVIRONMENT OF GREVENA

The province of Grevena is bounded on the west by the Pindos mountains and on the east by the Vourinos mountains. As these ophiolitic sequences were emplaced, sediment was shed into a Tertiary marine basin, the Meso-Hellenic trough. Mudstones, sandstones, and conglomerates formed in this marine basin through the Miocene. An erosion surface, cut across the deformed Tertiary sediments, is capped with a little deformed section of Plio-Pleistocene gravels, sands, and silts, derived from the mountains. Subsequent to the deposition of this sequence, streams incised through the sedimentary section. The main river, the Haliakmon, has incised more than 200 m. Incision, climate changes and land use have caused erosion on many hillslopes.

The streams had reached their present elevation by the early Holocene, but many valleys contain Holocene alluvial terraces that show a complex history of incision and alluviation. A major part of the geologic work on the Grevena project has been to sort out the history of hillslope erosion and valley incision and alluviation and to determine whether these changes are due to climate, tectonism, human land use and/or internal thresholds in the systems.

Grevena has a combination of continental and Mediterranean climate. Most of the rainfall comes in the fall and the spring, but some precipitation comes as summer thunderstorms - a continental feature. Winter temperatures are cold and snow is common even at the lower elevations of the area. Temperatures fall through the freezing point on many days each year.

The vegetation in the central Grevena area is dominated today by cultivated grain fields of wheat and barley. There are areas of oak woodland and, in the eroding areas, oak and juniper scrub land. Our studies of pollen and historic vegetation are incomplete, but they suggest that the pre-settlement vegetation was a combination of oak woodland and natural grassland.

NOMOS OF GREVENA

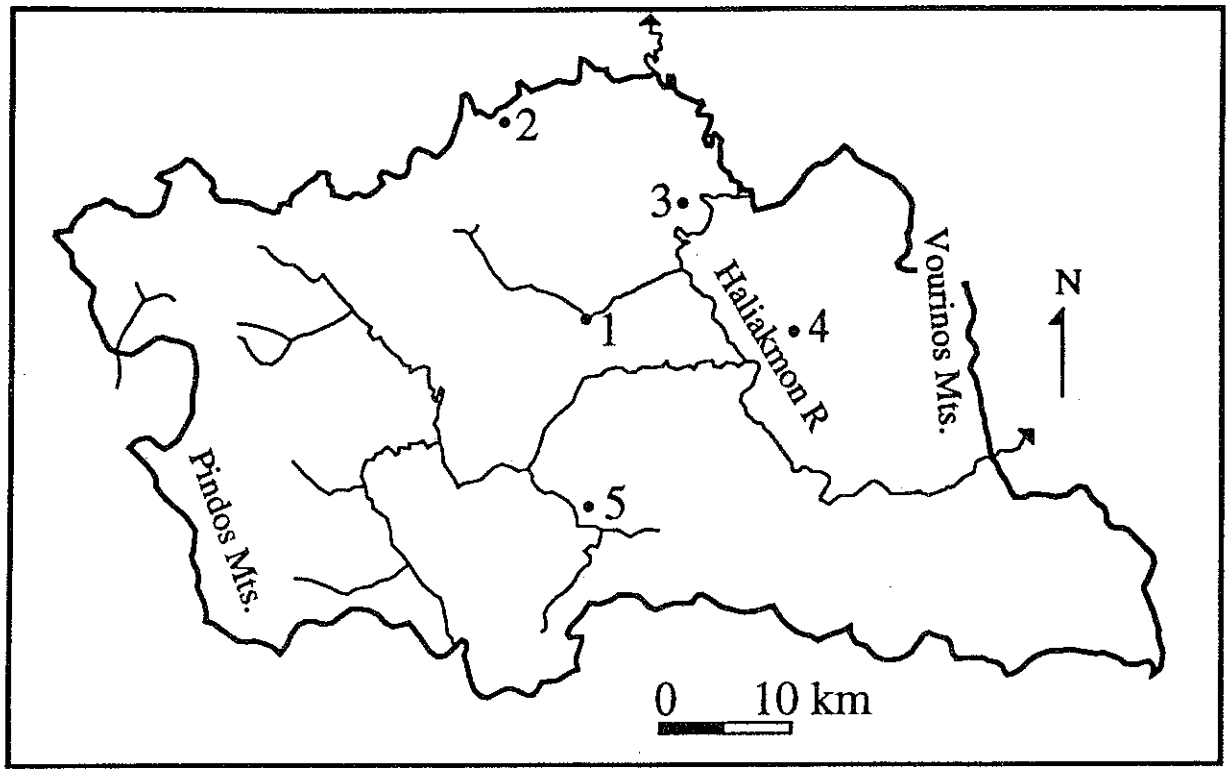

Figure 1. Location map of Grevena, showing location of archaeological sites studied in 1993: 1. Grevena City; 2. Paleogla, Dasaki; 3. Agia Paraskevi, Asprokambos; 4. Potamia, Knidhi/Itea; 5. Aghios Nikolaos, Emilianos.

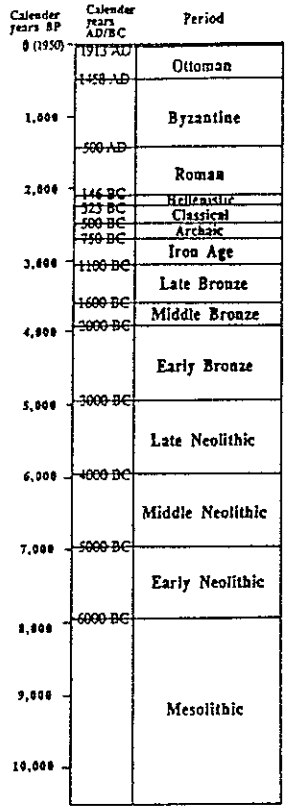

Figure 2. Archaeological timescale for Grevena. Note end of Turkish occupation of northern Greece in 1913. Byzantine period is the same as Medieval.

THE 1993 KECK PROGRAM

After a rendezvous in Athens with each other and with "Alex", our trusty van, we arrived in Grevena on July 16, just in time for a panegyri (festival) in the small village of Diporo, complete with band, dancing, and Greek food. We had many other scheduled and unscheduled "cultural experiences" during our month of work, reminding us that Greece continues to be a settled country, with a strong pride in its history and culture. We were based in the town of Grevena, a modern city of about 15,000 people, where we split our time between the Hotel Aegli and our small apartment that served as workroom/kitchen/dining hall/staff sleeping quarters. Every morning we shopped in the market for fruits, vegetables, bread and cheese and almost every evening we cooked pasta or vegetable dishes. When we went out to dinner, we commonly ended up at Takis' chicken place, with its amazing range of salads and wonderful grilled chicken. We of course dutifully avoided the local Amstel beer, Malmatina retsina and ouzo.

During the first several days of the project (July 17-July 23), we investigated possible sites for student projects and learned basic techniques of magnetic surveying, resistivity profiling and sounding, and soils description and analysis. Soil analysis has had an increasingly large role in archaeological studies, especially with the advent of techniques to determine relative ages of soils formed from similar parent materials. Geophysics, especially magnetic surveying and resistivity profiling and sounding, has been used on many archaeological sites to determine location of buried structures, layout of settlements and other archaeological features.

The six students wrote proposals and we spent most of the next several weeks collecting data at four major archaeological sites. During the project, we also went on four excursions: to the monasteries at Meteora, to the mountain village of Metsovo (a trip that allowed us to see the high Pindos mountains that border the province of Grevena on the west), to the seashore near Mt. Olympus and to Thessaloniki and Pella (to see the ancient Macedonia capital and the spectacular finds from Macedonian sites) and to the classic ophiolite localities of the Vourinos Mountains. We also participated in town and village life in Grevena, including attending two village festivals. The project officially concluded on August 14.

ARCHAEOLOGICAL SITES STUDIED IN 1993

The student projects focused on four archaeological sites. In all cases, the first part of the name is the site name and the second part is the nearest village. See Figure 1 for site locations:

1. Aghia Paraskevi, Asprokambos. This is a large multi-period site located on a wide, gently sloping ridge crest. In situ Late Neolithic pottery and burned mudbrick is exposed in a roadcut and Hellenistic and Iron Age pottery and tiles are found at the surface.

2. Paleogla, Dasaki. This large site on a long, steep ridge crest overlooking an important river crossing, is now heavily wooded in oak forest. Deep roadcuts expose many archaeological deposits from several periods, including Early Medieval (Byzantine), Roman, Iron Age and at least one other prehistoric period. Foundations of walls, still well-preserved, surround and cut across the site.

3. Potamia, Knidi/Itea. This is a very large site near an old citadel. It has some spectacular geomorphology, including a large landslide and numerous alluvial deposit and colluvial deposits. Settlement apparently occurred on several parts of the site, during at least the Early Neolithic, Hellenistic/Roman and Medieval (Byzantine) periods. Most of this site is presently vegetated by scrub and grass.

4. Aghios Nikolaos, Emilianos. This is a large Roman and Early Medieval (Byzantine) settlement site. Most of the site is relatively uneroded and presently cultivated, but there are extensive badlands in other areas. There is a Late Byzantine church surrounded by very large oak trees.

STUDENT PROJECTS

Students on the Keck program designed their own projects. Because we worked together, everyone pitched in to help with the Ace geophysical crew, the Super surveyors and soils describers, or to help resolve smaller problems. Four of the student projects involve data collected from more than one site:

Katie Donnelly used geophysics to locate buried structures at three sites. She coordinated magnetic and resistivity surveys at Aghia Paraskevi, Asprokambos, Paleogla, Dasaki and Aghios Nikolaos, Emilianos. Surveys over exposed walls at Paleogla will help Katie interpret the geophysical results at the other two sites, which have no structures exposed at the surface. Katie's geophysical results will also help determine the geophysical signature of the site geology.

Mary Greene described and measured the physical properties of soil materials in vertical sections at three sites. She described soil profiles at Potamia, Knidi/Itea, Paleogla, Dasaki, and Aghia Paraskevi, Asprokambos. In the field, Mary also measured the resistivity of soil layers in vertical sequence. In the lab, she measured the magnetic susceptibility of many of these same layers. Her results should help Katie Donnelly interpret the surface geophysical anomalies at the sites. She will also be able to determine some of the factors that control the geophysical properties of archaeologically significant layers.

Julia Daly measured qualitatively the phosphorus content of soil horizons and colluvial layers in described sections at all four sites. At many archaeological sites, phosphate increases with the intensity of human use. Julia has also determined how much occupation soils can be diluted by mixing with sterile colluvium and downslope movement and still retain an "occupation" phosphate signature. During this year, Julia has tested many of her samples in the lab to determine the specific form of the phosphorus. She and Mary Greene hope to test whether there is a correlation in archaeological materials between high magnetic susceptibility and high phosphate content.

Elizabeth Russell's project involves reconstructing the topography at the time of occupation at two sites, Potamia, Knidi/Itea and Aghios Nikolaos, Emilianos. At Aghios Nikolaos, topography on part of the site has been severely eroded (into badlands forms). At Potamia, the lower part of the site has been filled in with artifact-rich colluvium since occupation. In the field, Elizabeth mapped both sites with an automatic level and did some resistivity profiling and sounding to determine the shape of the colluvium/bedrock contact at Potamia. During this year, she experimented with computer-assisted design programs to come up with a picture of the landscapes at the time of occupation and of the sequence of changes that have brought them to their present condition.

Two projects focused solely on the site of Potamia, Knidi/Itea:

Bob Wilson is studying the evolution of the landscape in an area upstream of the large landslide. He has mapped alluvial terraces, determined their relative elevations, and described the soils on and within the terrace sequence in order to determine a chronology of erosion and deposition. There are a number of paleosols in the terrace sequences that may represent periods of landscape stability. Most of the terraces have a colluvial cover, so hillslope events will also be part of Bob's chronology. Bob collected some soil samples for lab analysis and charcoal from one colluvial unit that will help tie his chronology to absolute time. Bob's landscape history can be related to multiple occupations of the site, since some of the colluvial units contain artifacts (probably Early Medieval) and one of the alluvial sections contained Early Neolithic pottery.

Julie Williams is studying landscape evolution downstream of Bob Wilson's section. She also has mapped alluvial terraces, determined their elevations and described soils on and in the terraces. However, Julie's sections appear to be more alluvial (less colluvial) and she has collected three samples of charcoal for radiocarbon dating. Her study area is downslope and downstream from a large part of the site that was occupied in Hellenistic times; the obvious components of pottery and charcoal in parts of the alluvium may come from this site.

SUMMARY

The 1993 Keck projects gave students an opportunity to explore the interfaces between geology and archaeology. All project results will help us better understand the evolution of physical environment that humans inhabited and the effects of human habitation on the landscape.

A PHOSPHATE ANALYSIS OF SOILS FROM FOUR ARCHEOLOGICAL SITES IN NORTHERN GREECE

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INTRODUCTION

Soils associated with human occupation often have high concentrations of phosphorus as several forms of phosphate. Phosphate exists in all living beings in an organic form, and as these organisms die and decompose, this phosphorus is gradually converted to an inorganic form (Eidt, 1977). The inorganic phosphorus is insoluble, and will continue to accumulate in soil as long as a source for it exists. Within the soil, the phosphorus (as phosphate) bonds with aluminum, iron, calcium, and a small part of it becomes part of the soil solution (see fig. 1; Chang, 1957). Background phosphorous might exist in low concentrations most likely because of the presence of apatite in the parent material of the soil. Because the concentrations of phosphate produced by human occupation will be so much higher than those produced naturally, they can be detected and distinguished fairly readily (Eidt, 1977). Field and laboratory tests have been developed to qualitatively and quantitatively measure phosphate concentrations, and I have employed one of each of these methods in my research.

The project was a multi-purpose endeavor, involving not only evaluation of methods of phosphate analysis, but also the application of phosphate testing to examining landscape evolution and human interaction with the landscape in an area. Because Grevena is being surveyed for more extensive archeological research in the future, determining the lateral and vertical extent of soils which are believed to be in situ is important in evaluating potential sites. However, because we were also interested in learning more about the landscape evolution of the area, examining the colluvial fills near the landscape seemed a logical way of approaching the question of the relationship between human occupation and hill slope erosion. The close examination of these fills also provided an opportunity to test the phosphate detection and quantification methods, since they have been used primarily on in situ soils in the past.

METHODS

Because each of the four sites surveyed - Potamia, Agia Paraskevi, Paleogla, and Agios Nikolaos - posed different questions, soil samples were collected from different kinds of areas (surface, auger, vertical exposure) at each area. However, the field test performed with each sample was identical. This qualitative test, as described by Eidt (1977), involves applying an acid-molybdate solution to a small soil sample in order to form molybdophosphoric acid. This acid is reduced to a molybdenum-blue complex by ascorbic acid. The test is performed on filter paper, and as the molybdenum-blue complex is produced, a blue ring forms. In order to insure a fair comparison, the reaction is stopped after two minutes by washing the filter paper with citric acid; if this wash is not performed, the blue will eventually spread over the entire filter paper. The blue ring can be qualitatively evaluated for the intensity/darkness of the blue color (Eidt, 1977). I developed a five value scale: pale, light, medium, dark, and deep blue. Number values 1-5 have been assigned to these intensities for analysis purposes (see fig. 2). The filter papers were labeled and preserved for future reference. The consistency of the results seems to be most sensitive changes in the sample size; slight variations of the volume of the reagents applied, slight changes in concentration (due to possible evaporation), and the presence of calcium carbonate do not seem to affect the intensity of the blue in the ring (Daly, 1993). Qualitative comparisons of phosphate concentration could be made between sites based on the results of the field tests. This field test was also useful for determining the lateral and vertical extent of a site, whether or not soil from a particular horizon or fill was anthropogenically related, and to re-confirm or further explore areas that had shown up as magnetic or resistive anomalies.

In order to quantify the concentration of phosphorus, and perhaps determine land use (as in Overstreet et al, 1985), a soil fractionation technique was performed in the lab. The fractionation procedure is based on that outlined by Eidt (1977), and the colorimetry procedures are those described by Murphy and Riley (1962) and Watanabe and Olsen (1961) (see Fig. 3). The fractionation procedure results in the production of three fractions.

1. The first fraction is produced by two separations which extract that phosphate which is loosely bound Al-P, Fe-P, that which is resorbed by $CaCO_3$, and the very small amount already in the soil solution. NaOH and sodium citrate-sodium bicarbonate reagents (in separate steps) are used to remove these types of phosphate; the product is known as the NaOH+CB fraction.

2. The second separation uses sodium citrate - sodium bicarbonate - sodium dithionite to extract "tightly bound or occlusive phosphate absorbed by diffusive penetration or by incorporation with aluminum and iron oxides and hydrous oxides" (Eidt, 1330, 1977). This is known as the CBD fraction.