Climate, Geoarchaeological and Bioarchaeological practices, Landscape Archaeology: a multidisciplinary approach to evaluate the use and the transformation of a monastic site (Jure Vetere, Italy)

ROUBIS D.[1], SOGLIANI F. [1], LAZZARI M. [1], MERCURI A.M. [2]

ABSTRACT

This work is part of a multidisciplinary research project started on the archaeological site of Jure Vetere (region of Calabria, southern Italy). The excavation area is located on Mt. Sila Grande (1100 m a.s.l.), located 5 km to west from San Giovanni in Fiore, where between the end of the XII century and the first decades of the XIII century a monastic settlement rose. The archaeological research, carried out by IBAM-CNR on the site, with a multi-disciplinary approach (archaeological finds, ancient documentary sources, ethnoarchaeological data, photo-interpretations, geological and geopedological survey, pollen, plant remain and archaeometric analyses) permitted to discover a huge ecclesiastical building, characterized by two different phases, using a "Landscape Archaeology" approach. The palynological study, carried out on the layers deposited during these two phases coeval to the life time of the monastery, represents the basis to reconstruct the ancient plant landscape of the site, where the monastery was founded, and supplied the knowledge of the plant resources exploitation. Particular attention has been focused on the analysis of pedological horizons, burying the mediaeval building and its immediate neighbouring land, in order to evaluate its main characters and define the pedogenetic and geomorphic processes, coeval of the soil formation, which still less define the agrarian applications which assure subsistence to the religious community. The study was integrated with climatic data. In fact, the settlement history was correlated to different landscape evolution phases which were closely connected to local and global climatic oscillations.

Keywords: stratigrafic excavation; GIS; landscape archaeology; site exploitation territory; geoarchaeology; geomorphology; pedology; palynology; plant exploitation; palaeoenvironment; palaeoclimate.

1. THE HISTORICAL CONTEXT

The discovery of the first monastic foundation of Gioacchino da Fiore Abbot occurred during recent archaeological investigations (2001-2005), located on the top of Jure Vetere hill (Fig. 1), not far from St. Giovanni in Fiore town (Cosenza, southern Italy). This represents the first evidence of a rich and composed life story in terms of architectonic structures, spaces, estates, both religious and civil human and institutional relationship.

The cross-reading of ancient documents and archaeological data permitted to assert that the great religious building found on the top of Jure Vetere hill, corresponds to the foundation and the short life of the "*protocenobio*" of Joachim of Fiore Abbot.

The archive sources furnished ancient documents linked to the reconstruction of the monastic settlement of Jure Vetere. They consist of some biographical sources on Joachim of Fiore, written few years after his death and ~~of~~ some documents concerning donations and privileges, coming both from the Emperor, the Pope and Nobles, the monastery of Jure Vetere since the beginning of its foundation.

All these data gave a picture of a particularly important monastic foundation. Their reading, enriched and supplemented by the results of archaeological researches, shows the physiognomy of the economic and property model of the

[1] Institute of Archaeological and Monumental Heritage, National Research Council (IBAM, CNR). Corresponding author: d.roubis@ibam.cnr.it 2 Laboratory of Palynology and Palaeobotany, Department of Biology, University of Modena and Reggio Emilia.

first “Florense” monastery, as reflection of the monastic experience of its founder, between "continuity" with the Cistercian order and the new “Florense” order. The *Vita Beati Joachimi* suggests us that the Joachim Abbot had moved there with a few monks since 1188, while he was still the Abbot of the calabrian monastery of Corazzo, coming from Pietralata with the intention to build a new monastic order.

Figure 1: Geographical location of Jure Vetere monastic settlement (S. Giovanni in Fiore, Calabria, Italy)

The first document concerning the constitution of the first community of monks, wished by Joachim of Fiore in the site of Jure Vetere is a privilege of 1191, by which the norman King Tancredi, succeeded to William the Good and King of Sicily in Palermo in January 1190, grants Joachim with the possession of the territory "in the place called Fiore." In this donation, enriched by the offer, but rejected by Joachim, of the Matina Abbey (near San Marco Argentano), Tancredi joined " 50 annual *some* of grain and 300 sheeps for the perpetual maintenance of the monks."

The first monastic “*Florense*” foundation at Jure Vetere is an already well established settlement in the view of the XII century: it counted quite a lot of monks, a property which included cultivation lands, forests and waters next to the monastery and some possessions of the other neighbouring monasteries.

Moreover, they were added rights and freedoms, such as free grazing in the *tenimentum* of *Fluca* (in the territory of Rocca di Neto), the pasture right *in aliis tenimentis, que sunt per totam Calabriam*, without the payment of *erbatico* and *ghiandatico* and the right to salt extraction from calabrian *salinae*, and moreover the exemption from sale taxes.

Further privilege, which will be a primary source of income, was the freedom to collect incomes of *erbatico* and *ghiandatico* by those who, upon permission of the monks, wanted to graze their animals on lands owned by the monastery.

The last years of life of Joachim are characterized by an intense activity looking after its first foundation, recognized in the buildings came to light thanks to the archaeological investigations in Jure Vetere (Fig. 2), concerning the extension and the protection of property rights and the spiritual growth of the monastic community.

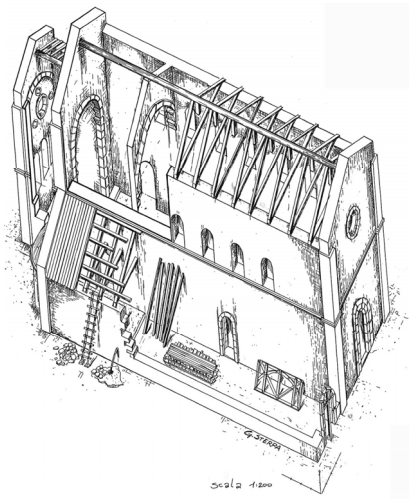


Figure 2: Jure Vetere: the monastic church discovered by archaeological excavations. Reconstruction hypothesis of Constructive Unit 1

With the Joachim successor, the Abbot Matthew (1202 to 1234), are coming again some direct informations about the monastery of Jure Vetere, regarding first disagreements of the monastic community living there, pressing to move in another place because: *Monasterium ipsum positum in montanis usque ventis expositum adeo est, ut pre acerbitate et assiduitate frigoris hyems not solum sibi ver vendicaverit et autumpnum, sed in menses estivos suos terminos dilatari*. The request by the monks is shown in the proposal, addressed to the Pope Innocent III, concerning a lands exchange with the Archi-

bishop and the “Capitolo” of Cosenza, in order to get the territory of Botrano, close to Paternò Calabro, probably to move in a more climatic favourable site.

A serious crisis signed the monastic community and the monastery of Jure Vetere in 1214, when the written sources give evidence of a fire which had destroyed most of the buildings of the monastery. The same fire is mentioned by Constance of Aragona, wife of Frederick II, in two documents of January 1215 and June 1216: the first is a renewal of the donation to the Fiore monastery of a land in the territory of Cerenzia, by the earl of Crotone Stefano Marchisorti, and the second is the donation of an additional ground. The monastic settlement suffered a traumatic event, that had perhaps caused the collapse and the destruction of some of its parts, which were subsequently restored, due to the economic help of the Kingdom himself.

But again were the climatic troubles to affect negatively the survival of the monastic community at Jure Vetere. The Pope Innocent III, in a document dated on February 1215, address the Matteo Abbot with these words: *Cum igitur sicut referentibus vobis accepimus locus in quo est vestrum monasterium usque adeo frigoribus sit expositus et hyemali frigiditati subiecto ut quia locus in quo habitatis est angustus et asper, liceat vobis discendere Calabriam, ubi possitis in possessionibus vestris locum ad habitandum auctoritate nostra vobis construere aptiorem*

We have found the latest mentions regarding urgent transferring needs in a more favourable site, in a concession of the St. Severina Metropolita, in March 1219, in which it is possible to read: *quod in frigidis Sylae locis noscitur esse situm, ubi nec animalia, quorum velleribus monachi vestiuntur, algoris rigiditate yemare sinuntur, nec legumina, cotidiana monachorum cibaria, sufficienter fieri possunt, proposuimus de amplis possessionibus ecclesiae nostrae subvenire tibi et monasterio tuo in aliquo tenimento, ubi eiusdem monasterii praedicta et necessaria quaeque valeant exerceri*.

It is probably between 1215-1216 and 1220 that the first “Florense” monastic community changes his seat permanently, and moves but not far, in San Giovanni in Fiore, where the Abbey is now located.

2. ARCHEOLOGICAL INVESTIGATIONS AND STUDY METHODS

The monastic settlement wished by Joachim of Fiore between the last years of the XII cent. and the beginning of the XIII cent. is located in a valley of Sila Mount, at about 1100 mt a.s.l. (Fig. 3). It is characterized by the presence of abundant water (perennial rivers, such as the Arvo river and its tributaries) and rich of vegetation (agricultural and sheep-rearing grounds, enriched by abundant forests allowing the supply timber for everyday use as fuel and as raw material for the building). Due to the whole analysis of the building, seems to be evident that the location of the monastic structures discovered, meets fully the standard requirements for the usual course of the monastic life.

The excavation periods have provided a chronological sequence of life settlement, completed by some considerations on the various diachronic aspects which characterized this area. The first chronological period (Period I), running from the last decade of the XII c. until about 1213 / 1214 , corresponds to the construction, occupation and destruction of the entire first religious building (Constructive Unit 1: CU 1). In the second period (Period 2), short-lived and not exceeding the second decade of the XIII c., some works were carried out on the restoration, rebuilding and occupation of the second and last religious building (Constructive Unit 2: CU 2) until the building site was definitively halted (Fig. 4). It was, presumably, towards the end of the second phase that the monastic community was permanently moved elsewhere and the site was adandoned

The whole monastic community finally changed his seat permanently, and moved in San Giovanni in Fiore, a site climatically more suitable for the monastic life.

The investigations on this site were set up adopting the multidisciplinary approach of the "Landscape Archeology", following these "steps": 1) documentary researches; 2) intensive survey of the entire territory; 3) photointerperetation 4) georadar, geomagnetic and geoelectric prospecting, 5) archaeological stratigraphic ex-

cavation, helped by water flotation to recover the remains of plants and by the study of structural and typological stratigrafical masonry units and by archaeometric and chronotypological analysis of artifacts; 6) landscape analysis supported by ethnoarchaeology, cost surface analysis and pollen samples; it was also set up the geological and geomorphological study of the area, using soil sampling characterization.

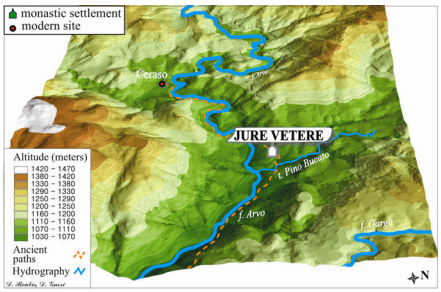


Figure 3: Jure Vetere: the Digital Terrain Model of the area

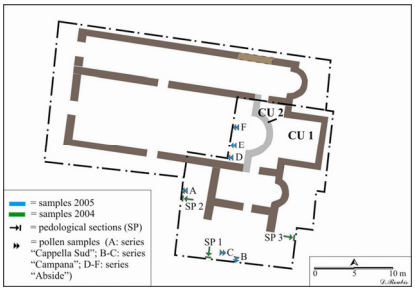


Figure 4: Jure Vetere: location of pedological and pollen samples from the Church

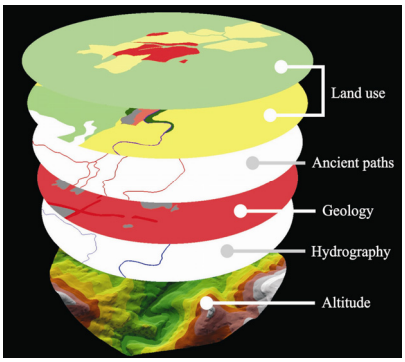


Figure 5: Jure Vetere: some of the layers used for data management and analysis performed on GIS

The data resulting from the researches carried out on the field and those obtained through the maps elaboration were computerized to be developed with the Geographic Information System. The documentation as a whole relating to the investigated area (territorial plans, geological and pedological maps, composite planimetries, overlays, aerial and satellite photographs), have been vectorized with a software, in which are linked the corresponding alphanumeric data stored on the database. They were realized distinct topological overlays, managed separately: these are specific vectorized layers as 1) level curves; 2) rivers, streams and springs; 3) peculiar geological elements; 4) ancient roads; 5) vegetation coverage of the area (Fig. 5). The GIS analyses demonstrated that with the growth of the monastic community, two main areas was required to obtain the primary and secondary materials necessary for the life in the monastery: an inner area characterized by intensive exploitation of resources, and an outer area for subsidiary production activities of a more extensive nature. The GIS-based processing of the geographical and territorial information, concerning the different types of soils, also made it possible to identify various potentially exploitable Environmental Units. Thanks to different procedures, we got an area shared in agricultural soils, land suitable for grazing of good quality or potentially arable, soils suitable both for grazing and for the exploitation of forests and not productive soils. Particularly important for the processing of the data via the GIS, was the study of the ancient environment which surrounded the monastery, at the time of its foundation and during its brief life.

Due to the archaeological data, it has been possible to realize the virtual reconstruction of the monastic complex inside its landscape.

The study of ancient written documents and of the archeological stratification, joined to the geopedological and pollen analysis, gave the information required for a complete interpretation of the exploitation dynamics of the surrounding territory, by the monastic community. Moreover the investigations allowed us to comprehend the economic aspects and the way of exploitation of the land properties by the monks and, above all, the climatic conditions; finally the

"luck" of this particular monastic foundation, read through the landscape archeology.

3. GEOMORPHOLOGY, PALEOENVIRONMENT AND PALEOCLIMATE

In order to reconstruct the paleoenvironment and paleoclimate in the study area and to correlate the history of Jure Vetere settlement with the different evolutive phases of the landscape, which are closely connected to the local and global climatic conditions coeval of the monastic settlement, an integrated multidisciplinary approach has been allowed. Several data have been analyzed and correlated, such as climate data (rainfall and temperature), pedological and geochemist (composition, thick, texture, porosity, skeleton, pH, colour, content of organic matter, basic saturation, soil cationic exchange capacity), geomorphology (orographic, hydrographical and morphoevolutive characters of the landscape) and archaeological (stratigraphic units, historical sources, archaeological dating on pottery found inside the pedological horizons).

Geological setting

From a geological point of view, the study sector is located along an axial zone of Sila Grande Massif relief, that represents a section of the Hercynian orogenic belt of western Europe, where allochthonous crystalline basement rocks are exposed to form the highest tectonic units (Calabrian Arc) of the southern Italy fold–thrust belt. The Sila Massif consists of Paleozoic intrusive and metamorphic rocks locally covered by unmetamorphosed Mesozoic sediments. The Palaeozoic rocks consist of gneiss, amphibolite, schist and phyllite, affected by various Alpine metamorphic events and intruded by the Late Hercynian Sila batholith characterized by multiple intrusions of granodiorite

Climate and landscape characters

The Jure Vetere site is located at about 1100 m on a gently dipping dissected landform, reasonably the remain edge of a periglacial surface. The woody coverage is mostly grooving on the hill slope, close to the main stream, the Arvo River. The landscape is characterized by high relief dynamics with convex slopes subject to periglacial climatic conditions during last wurmian glacial thermal minimum.

The study area has a typical *upland Mediterranean climate*, i.e. a temperate humid climate with mean monthly temperatures ranging from -1 °C/1 °C (in January) to 16–18 °C (in August) and a not particularly prolonged dry summer (T_{max}>22 °C), with July (and sometimes August) having less than 30 mm rainfall. Mean annual precipitation reaches 1400–1600 mm according to elevation and aspect.

During winter the snow cover can be preserved up to 6 months. In more details, temperature data recorded at Camigliatello Silano (1250 m a.s.l.) and Monte Scuro (1720 m a.s.l.), the thermopluviometric stations closest to the study area, are available for the periods 1959–1970 and 1952–1980, respectively. Mean monthly values during the four coldest months (December to March) range from -0.7 (recorded in January) to 3.8 °C (in March), with mean monthly minima between -2.6 and 0°C.

Daily temperatures below zero commonly occur from November to April and, although no detailed information about amount and frequency of diurnal cycles is available, oscillations a few degrees around zero can be supposed to occur rather frequently. Mean monthly temperature of the warmest month (August) is 16–18 °C, with a mean monthly maximum of 24 °C.

The pedoclimate is characterised by a *mesic* soil temperature regime and a *udic* soil moisture regime. As a consequence of these climatic conditions, an important role seems to be played during the coldest months by a variety of cryonival phenomena, influencing rock degradation and fragmentation, slow mass movements and soil processes.

Geomorphology and pedological analysis

Geomorphological survey has been carried out to evidence and describe the main geomorphic factors and processes which check the landscape and soil evolution, both linked to climate conditions.

Surface erosion strongly controls soil development: soil profiles in wide areas appear extremely thin (sometimes only few centimetres deep), showing simple and non-differentiated profiles for a continuous soil rejuvenation.

Pedological profiles				Classification USDA/New Russian Tax. Soil System	Stratigraphic Archeological Units	Age Pottery, metals	Historical / climatic Event
Horizons	**Description**	**Diagnostic elements**	**Pedogenetic processes**				
O	Humic horizon	High content of organic matter and low acid saturation index.	heap of organic matter, neo-formation of clays and iron oxides, clay lessivage and heap of biogenic cations.		US 2	XX Cent.	Starting of actual temperate worm phase (farming use of soil)
Ap	Porous anthropic ploughed layer	Obliteration of all pre-existing pedologic structures and formation of a structural homogeneous layer at the bottom defined by a ploughing surface. High acid saturation index.	Five-yearly mechanical remixing of horizon, moderate biological activity, acidification, neogenic clays formation, lessivage and cations lixiviation.	Inceptisols *anthropic farming use*			
E	Eluvial layer	Low clay content, colour brightening, vacuolar structure. High acid saturation index.	neogenic clays formation, clay translocation towards lower horizons, cations lixiviation .	Inceptisols	US 16	XVII-XIX Cent.	Building in a bad state of conservation (ruin) and deserted (doc. 1774) /Cold phase (little glacial age until 1850) Sporadic site frequentation between XVI and XVII centuries
Bt	Argillic horizon (neo-formed clays moved from E or A horizons)	Common to very abundant clay, prevalent reddish and brown colours. Low acid saturation index. Coatings stacked on aggregate outer surface or within pores.	Illuvial of clay and iron oxides coming from higher horizons and accumulation of alkaline cations	Inceptisols	US 71		
AB	Buried organic horizon with anthropic elements	High content of humic organic matter, and low acid saturation index.	heap of organic matter, humification, acidification, illuvial clay, lixiviation of humic compounds and cations accumulation.	Buried paleo-horizon A *(Mollisols ?)*	US170	XIII – XVI Cent.	Dilapidated state of structures and collapses in XIV cent. (Cold phase)
U2-U3	Urban soils – heap of inert anthropic deposits	*Melange* of soil and rubbles.	Soil and rubbles weathering with formation of iron oxides (ferritization). Cations lixiviation.	Urbic	US 246	XIII Cent.	Desertion of site (1220)/ Cold phase Restore and reconstruction of the apsidal building CU 2 /starting of medieval cold phase *Doc. (Rif. Bibl. Reg. Innocenzo III)*
U1	Urban soil ground level	High soil consolidation, fine texture and abundant iron oxides.	Rubbles mixed to soil weathering with formation of iron oxides (ferritization).	Urbic	US 374/ US 312	XII- XIII (1214) Cent.	First settlement (1188/1194) – death of Abbot Gioachino (1204) – fire and collapse CU 1 (doc. 1214) – construction of a bronze bell/ End of medieval warm period
C	Granitic soil on bedrock– locally called *"sanso"*	Abundant iron oxides and skeleton, intense yellow colour, high acid saturation index.	Mechanical weathering of bedrock and mono-mineral skeleton formation due to high temperature range, ferritization, illuvium of clay minerals and neo formation on site of clays and iron oxides.	Alfisols *truncated*	-	<XII Cent. Medieval warm age	Granitic soil formation/ Warm phase (optimum climatic)

Figure 6: Jure Vetere: relationships between pedogenetic processes and historical-climate phases occurred on Jure Vetere archaeological site

Erosion appears particularly enhanced on the steepest slopes, where it exceeds regolith and soil production resulting from chemical weathering. On the other hand, weathering profiles may reach even several metres in depth; furthermore, one to some metres thick, well-developed soils are preserved in protected flat landforms, such the case study, or depressions and along gentle footslope belts, where also intense reworking and accumulation of colluvial material is observed. Pedogenetic processes have interested the prevailing granodiorite lithotypes and acting in depth these processes have chemically weathered the local rocks producing coarse-grained soils with a prevalent weathering of feldspars, hornblende and biotites.

A particular attention has been focused to analyse the pedological horizons beneath medieval building foundations and surrounding areas, evaluating and defining their main characters and pedogenetic and geomorphic processes, coeval to the soil formation, and finally evaluating also the possible agrarian applications useful to subsistence of Joachim Abbot religious community.

The site could be a good example of polycyclic supplying of sediments and soils represented by an almost continuous record represented by an almost continuous record of climate and historical events occurred from medieval age to the present.

Pedological analysis has been carried out by means the study of pedological sections in the field (micromorphology and sedimentology) and laboratory analysis on samples of the different pedological horizons (Fig. 4).

On the whole 8 pedological horizons have been distinguished well evidencing the interaction between natural pedogenetic processes and human activities linked to the monastic settlement of the XIII and XVI centuries (Fig. 6). Pedological profiles surveyed in cuttings not far one from another show important lateral variations due to morphological setting of bedrock, to human activities (pedogenetic anthropic deposits, field irrigation) and geomorphic and colluvial slope processes. In particular, the deeper horizon continuous throughout the whole sections is the C horizon (*Alfisols*). It is produced by weathering of the granite basement, where sferoidal boulders (0.8-1.5 m of diameter) due to combined action of chemical weathering and crioclastic disgregation are frequently present. It is also characterized by a loamy-sand or sandy-loam texture, low content of organic matter and a neutral pH (7.4) due to the presence of caolinite.

Monomineral grains of quartz and potassic feldspar deeply altered characterize the skeleton

of this horizon. This pattern is index of a high annual average of temperature associated with high thermic excursions. On the top surface of the *Alfisols* horizon C a thin reddish compacted deposit of the XIII century has been recognized (*urbic soil* U1). This anthropic deposit, associated to the ground level of monastic settlement, is characterized by a melange of soil and granodiorite sand and buried by two reddish piles of rubble mixed to soil (*urbic soil* U2 and U3), deeply altered, with lentiform geometry and lacking of free carbon. The U1 horizon presents a marked reddish hue because of fire that destroyed the first building on 1213-1214.

The piles are buried by a dusky brown and dusky yellowish brown horizon, paleosoil A (*Mollisol ?),* characterized by a high density and content of fossil organic matter, low porosity, poor skeleton and containing pottery and bronze residual working products of the XIII century. The genesis of this horizon could be linked to a deposition occurred during a climate colder of -0,2°C and wetter in comparison with the previous annual averages. Successively, this horizon has been fast buried by the colluvial deposits of an *Inceptisols*.

Inside the *Inceptisol*s a dark yellowish brown argillic horizon Bt and an eluvial horizon (E) have been distinguished, both linked to a sporadic frequentation of site between XVI and XIX centuries. The Bt horizon is characterized by neo-formed clays moved from E or A horizons and by common to very abundant clay and low acid saturation index. Coatings stacked on aggregate outer surface or within pores are also present. The E horizon is low clay content, colour brightening, vacuolar structure and high acid saturation index.

Because of agricultural machination of the second half of XX century, a horizon Ap, affected by ploughing and an organic horizon O have been developed to the top of horizon E. The upper layer of horizon Ap, close to the ploughing level, shows a fluctuation in red tonality which could be interpreted as an appreciable podzolization presumably due to global phenomenon of "acid rains".

Figure 7: Jure Vetere: pollen sampling for the palynological study (left), and pollen of Poaceae (right, top) and Pinus (right, bottom)

4. POLLEN SAMPLING: METHODS AND RESULTS

Pollen analyses focused on reconstructing environment and plant landscape of the tableland where the monastery was founded. They also provided data useful to interpret exploitation dynamics of the land surrounding the site, carried out by the monastic community. During the 2005 excavation, 40 pollen samples were collected from three records located in three different sites of the mediaeval monastery excavation area (Fig. 7).

First pollen data were obtained from layers which preceded or were coeval to the life time of the monastery. These samples were collected in the 'Bell Sequence', in the western side of the excavation area, near the south chapel (Fig. 4). The sequence consisted of one part collected from the ditch for casting bell excavated into the floor of the monastery (5 samples dated before the monastery – Period 0); and a second part collected from a trench next to the ditch including layers from the Mediaeval age onward. The 4 samples coeval to the monastery, at the base of this trench, were reported in this paper (Period I).

About 4-8 g dry weight samples were treated using tetra-Na-pyrophosphate, HCl 10%, acetolysis, heavy liquid separation (Na-metatungstate hydrate), HF 40% and ethanol. Permanent pollen slides were mounted in glycerol jelly. *Lycopodium* tablets were added to calculate pollen concentration (pollen grains per gram = p/g). Microscopical analyses were carried out at 400x and 1000x magnifications with light microscope. Identification was performed

with the help of keys, atlas and reference pollen collection. Cerealia pollen identification was based on Beug (1964), Andersen (1979), Faegri and Iversen (1989, with correction factor for glycerol jelly). Percentages were calculated in a pollen sum which excluded the overrepresented Cichorioideae. This pollen and Pteridophyta spores were calculated as percentage on the pollen sum plus themselves.

Samples had different pollen content. The 5 samples from the pre-monastery layers had a very low concentration (50-100 p/g), and only 60 pollen grains were found. Therefore, they were grouped into one single sample to calculate percentages. The 4 samples from layers of the monastery life had sufficient pollen content (1500-2000 p/g).

The state of preservation was also variable, even in the same sample thus suggesting that pollen had arrived from different sources in the samples.

Especially, in pre-monastic layers, some pollen grains were burned and other should have been destroyed by the bell fusion activity. Pollen from Period I was generally better preserved, and pollen clusters revealing flower presence in place were sometimes observed.

The pollen list includes 97 taxa (33 woody, and 64 herbaceous plants). *Pinus*, Cichorioideae and Poaceae-wild group were prevalent in the spectra. Common taxa were *Alnus*, *Castanea* and deciduous *Quercus*; Chenopodiaceae, *Centaurea nigra* type, *Plantago*, Apiaceae and *Urtica*. Other taxa were found only Period 1, i.e. *Corylus*, *Juniperus* type, *Fagus*; Caryophyllaceae, Asteroideae, *Hornungia* type, Cyperaceae, *Hordeum* group, *Phragmites australis* cf., *Vicia/Lathyrus* type, and Ranunculaceae.

Forest cover is slow (trees plus shrubs < 50%), with conifers (*Pinus*, *Abies*, *Juniperus* type) and deciduous broadleaf plants of oak woods (deciduous *Quercus, Corylus*, *Acer campestre* type, *Carpinus betulus*, *Ostrya carp./C. orientalis* type, *Fraxinus excelsior* type, *F. ornus*, *Ulmus*, *Tilia*, etc.) and riparial woods (*Alnus, Populus, Salix*). Mediterranean plants (*Olea europaea*, *Quercus ilex* type, *Pistacia*) were found in Period I samples (1-2%). Anthropogenic pollen indicators were common. They included wild synanthropic plants (8%, mean of Period I, and of all spectra) and cultivated trees and herbs (11%, mean of Period I; 6% in all spectra as *Castanea* is also present in the Period 0). Cereals had significant amount (7%, only in Period I) and were present as both pollen of barley (*Hordeum* group) and oat/wheat group (*Avena/Triticum* group); also few millet (*Panicum*) were observed. *Papaver rhoeas* type and *Aphanes* type were weeds of fields. Cichorioideae, together with *Centaurea nigra* type, Chenopodiaceae and *Trifolium* are indicators of pastures.

Archaeoenvironmental reconstruction by pollen

Though some problems of pollen preservation can have affected the spectra, especially those from Period 0, the set of samples permitted to obtain a fairly complex archaeoenvironmental reconstruction of the site area.

Before the monastery was built, the mountains in the surrounding area were covered with pine and deciduous oak woods, while hygrophilous woods and wet environments were nearer to the site.

Plant cover was open in the site. Signs of anthropic influence, probably due to pastoralism, were present.

After the building of the monastery, in the Mediaeval period, besides the above mentioned woods, beech-fir woods were also spread in the mountains. The landscape was open and anthropogenically shaped. Monks exploited the territory in a more continuative way reflecting their sedentary. They cultivated cereals and kitchen gardens, in little fields near the monastery. Large part of their economy was also based on the maintenance of pastures for their sheep, which probably frequently grazed more far from the site.

5. PALAEOCLIMATE DISCUSSION

The integrated and multidisciplinary analysis, carried out on the site of Jure Vetere, permitted to correlate both the history of the settlement to the various evolutionary phases of the landscape and the coeval climatic conditions that have probably influenced the permanence of the religious community on the Sila Mount. We point out that the altitude of 1100 m a s.l.

made this site particularly sensitive to thermic changes caused by the extreme climatic conditions. In particular pollen and geopedological data have concurred to link archaeoenvironmental features of the site to global/local forcing factors depending on climatic oscillations. In fact, the monastic phase of Jure Vetere, between the end of the XII and the first decades of the XIII century, has been marked by a climatic change towards more humid and cold conditions that accentuated the uncertainty of life of the monastery.

During such period, testified by a scient--ific literature, the Europe has been interested by various palaeoclimatic conditions (Fig. 8). In fact, the medieval period is famous as Medieval Warm Period (800-1300 A.D.; 1000-1200 according to Lamb, 1965) due to warmer climatic conditions, estimated by the European centre at about 1°C higher (medium temperature of the warmer month).

Generally, the warmer phase in the Medieval Warm Period is that between 950 and 1045 A.D, while that most humid one was dated between 1200 and 1300 A.D. At the end of the Medieval Warm Period (XIII century), the climatic deterioration, towards cold temperatures, as the prelude to the Small Glacial Age, carried on an expansion of the ice on the Alps and in north Europe, and the abandonment of Mediterranean cultivations in the northern regions of the continent.

In this general climate context, from the point of view of the pedological analysis at Jure Vetere, the conditions of global temperature have certainly influenced, also to local levels, the morphogenetic processes of the site, and still more on the conditions of life, subsistence and permanence of the monastic settlement (Fig. 9).

Comparing the pedological horizons together with the relative archaeological Stratigrafic Units, based on archaeological finds, with the temperature curve of the last 1000 years (estimated in respect to the average temperature calculated from 1961 to 1990), a substantial correspondence emerges between those climatic and archaeological phases.

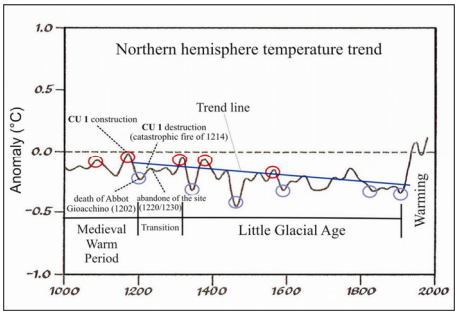


Figure 8: Graphic plot of the northern hemisphere temperature trend during last 1000 years (after Fagan 2001), with evidence of cold and warm peaks respect to historical events, occurred on Jure Vetere archaeological site, between the end of Medieval Warm Period and the Little Glacial Age

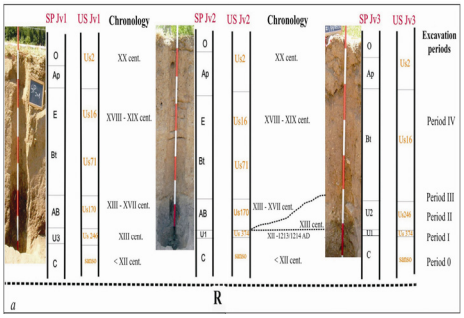
In particular, some significant peaks were recorded during the period of monastic community in the curve of the global medium temperatures. Towards the end of the XII century, in fact, the curve registered a warm peak during the first settlement of the monastic community on the Sila Grande.

In the third decade of the XIII century the community definitively abandoned the site. One of the more probable causes seems to be linked to severe humid and cold climatic conditions testified with a mollisoil (horizon AB), characterized by a high percentage of fossilized organic substance. Such conditions have determined the velocity reduction of the chemical reactions depending on humid conditions and, above all, on lowlands temperatures.

Actually pollen analyses showed that mixed beech-fir woods were present during the medieval phase of occupation of the monastery, probably spreading in a relatively wet and cool phase.

Nevertheless, the presence of *Olea*, found in samples from the first phase of the monastery life, testified that the Mediterranean warm-requiring tree lived in the area. This pollen was found only in traces, and maybe the olive tree, not suitable for the mountain cultivation, has moved in altitude carrying its cultivation line a little more up of the current (900 m a.s.l.) during a general warmer climatic phase (Medieval Climatic Optimum).

The last phase of life in the Jure Vetere monastery (1202 – 1214), corresponds to one climatic deterioration threshold (more humid and colder), during which the expansion of the beech and fir trees forests occurred, so that to make the life in the monastery much difficult for daily necessities.



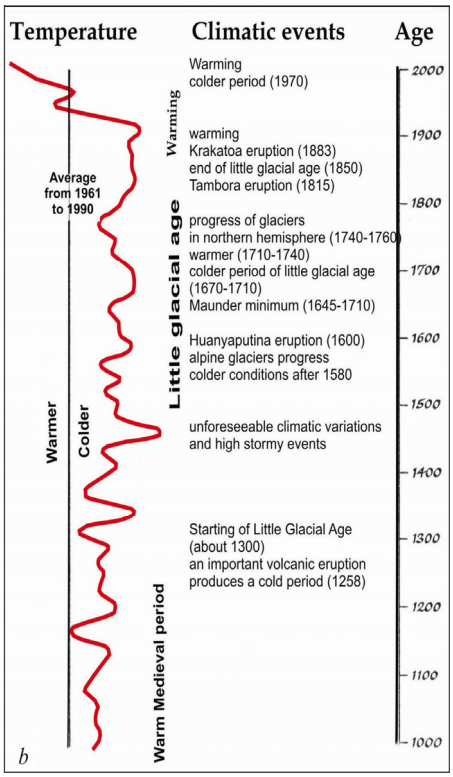


Figure 9: Jure Vetere: comparison between the pedological sections, the stratigraphic-archaeological units and global temperature curve during last 1000 years (after Fagan 2001)

6. CONCLUSIONS

The life in the monastery caught up a particularly uncertain situation during the most severe winter months. In fact, during this periods the system of sustenance, founded almost exclusively on the supplies, guaranteed with difficult a level of self-sufficiency quite over to the collapse threshold.

In the following years of the death of Joachim of Fiore Abbot (close to 1202), the widening of the monastic community, after the arrival of new monks, yields necessary to assure them an existence in a less severe zone from the climatic point of view and to guarantee supply of alimentary assets.

The problems found by the monks on Sila mountain, emerge clearly from ancient archieve sources; starting from the year 1202, in the documents are often pointed out the adverse climatic conditions to which the zone of the Jure Vetere monastery (flagellated by the coldest winter winds) was affected. The documents show also the repeated attempts of the monastic monks to transfer their community in a more suitable place.

Moreover, the catastrophic fire of 1214, discouraged the monks furthermore. The fire

Figure 10: *Jure Vetere: Constructive Unit 1. Fire destruction before October 1214: macro charcoals remains*

remains have been found by the archaeological excavations and allowed to deduce that the action of the fire stopped the construction of the ecclesiastical building (CU 1) (Fig. 10).

The traumatic event gave a hard blow to the monastic life, determining the degeneration of an already compromised situation on the environmental and economic side. After a short period during which an attempt to reconstruct the church was carried out (CU 2), approximately during the second or third decade of the XIII century, the religious moved away definitively in a close area, equally rich in natural resources and placed at an lower altitude; such a place, more favourable to the monastic community prosperity, corresponds to the actual location of the S. Giovanni in Fiore Abbey.

Acknowledgements

The excavation on the site of Jure Vetere benefited from the participation of several researchers afferent to the Institute of Archaeological and Monumental Heritage (IBAM) of the CNR, besides students from the Post-graduate School of Archaeology of Matera (University of Basilicata, Italy).

Figures 1, 3-5, 10: D. Roubis; figure 2: G. Sterpa; figures 6, 8-9: M. Lazzari; figure 7: A.M. Mercuri (graphical elaboration).

REFERENCES

Alexandre, P., 1987. Le climat en Europe au moyen age. Ed. EHESS (Ecole des Haute Etudes en Sciences Sociales), Paris, p. 828.

Andersen, S.T., 1978. Identification of wild grasses and cereal pollen, Danmarks Geologiske Undersøgelse, Årbog, pp. 69-92.

Atzori, P., Ferla, P., Paglionico, A., Piccarreta, G., Rottura, A., 1984. Remnants of the Hercynian orogen along the Calabrian-Peloritan Arc, southern Italy: a review. Journal Geol. Soc. London, 141, pp. 137-145.

Beug, H.J., 1964. Untersuchungen zur spät- und postglazialen Vegetationsgeschichte im Gardaseegebiet unter besonderer Berücksichtigung der mediterranen Arten, Flora, 154, pp. 401-444.

Fagan, B., 2001. la rivoluzione del clima, Milano.

Faegri, K., Iversen, J., 1989. Textbook of Pollen Analysis, IV ed. Faegri, K., Kaland, P.E. & Krzywinski, K. (eds.), New York.

Fonseca, C.D., Roubis, D., Sogliani, F., 2007. Jure Vetere: ricerche archeologiche nella prima fondazione monastica di Gioacchino da Fiore (indagini 2001-2005), Rubettino Editore, Soveria Mannelli.

Koppen, W. 1936. Das geographische system der Klimate. Handbuch der Klimatologie. Gebrunder Borntraeger, Berlin.

Lamb, H.H., 1965. The early medieval warm epoch and its sequel, Palaeogeography, Palaeoclimatology, Palaeoecology", 1, pp. 13-37.

Lazzari, M., Gallini, L., Zotta, C., 2007. L'insediamento monastico gioachimita di Jure Vetere (Sila Grande) nel contesto geomorfologico e pedoclimatico medioevale. In, Fonseca et al., 2007, pp. 35-52.

Lebedeva, I.I., Tonkonogov, V.D., Shishov, L.L. 1993. Classification place and systematic of human transformed soils. Pochvovedenie, 3, pp. 98-106.

Lulli, L., Vecchio, G., 1996. I suoli del bacino del Lago Cecita nella Sila Grande e la loro sensibilità. Agric. Ric. 164/165/166, pp. 113–122.

Mercuri, A.M., Accorsi, C.A., Bandini Mazzanti, M., Bosi, G., Trevisan Grandi, G., 2007. Il paesaggio vegetale di Jure Vetere prima e durante la vita del monastero medievale sulla base dei primi dati pollinici. In, Fonseca et al., 2007, pp. 269-287.

Messina, A., Compagnoni, R., De Vivo, B., Perrone, V., Russo, S., Barberi, M., Scott, A. B., 1991. Geological and petrochemical study of the Sila massif plutonic rocks (northern Calabria, Italy). Boll. Soc. Geol. It., 110, pp. 165-206.

Roubis, D., 2007. Archeologia del paesaggio a Jure Vetere: il protomonastero florense e le sue risorse territoriali. In, Fonseca et al., 2007, pp. 389-416.

Roubis, D., Sogliani, F., Lazzari, M., 2004. Ricerche archeologiche a Jure Vetere (Comune di S. Giovanni in Fiore - Cosenza): la prima campagna di scavo del 2002 e le indagini geopedologiche. SIRIS, 4, 2003, pp. 1-20.

Scarciglia, F., Le Pera, E., Critelli, S. 2005. Weathering and pedogenesis in the Sila Grande Massif (Calabria, South Italy): From field scale to micromorphology. Catena, 61, pp.1 –29.

SOCIETA' ITALIANA DI SCIENZA DEL SUOLO 1985. Metodi normalizzati di analisi del suolo. Edagricole, Bologna.

Sogliani, F., 2007. Il monastero florense da Jure Vetere a S. Giovanni in Fiore: le vicende storiche. In, Fonseca et al., 2007, pp. 23-30.

SOIL SURVEY STAFF 1999. Soil Taxonomy, A Basic System of Soil Classification for Making and Interpreting Soil Surveys. Second edition. U.S. Department of Agriculture, Natural Resources Conservation Service. Agriculture Handbook n° 436, p. 869.

USDA 1998. Keys to Soil Taxonomy. 8th ed. U.S. Dept. Agric., Soil Survey Staff, Nat. Res. Cons. Serv., Washington D.C., p. 326.