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GRUPPO RICERCA GEOMORFOLOGIA CNR

GEOMORFOLOGIA DEL TERRITORIO DI FEBBIO TRA IL M..CUSNA E IL F. SECCHIA (Appennino Emiliano)

ABSTRACT: GRUPPO RICERCA GEOMORFOLOGICA CNR, Geology of the Febbio area, between Mt. Cusna and Secchia River (Emilian Apennine) (IT ISSN OO84-8948, 1982).
The research started with a geomorphological survey in which 25 researchers took part. Since then numerous other survey campaigns have been carried out in order to complete and standardize the geomorphological map. Various other themes have also been studied regarding climate, morphometry, Pedology, Hydrogeology and soil-use. The choice of this area may be justified by numerous geomorphological points of view. It includes much evidence of the last glaciation, particularly in the form of moraine heaps. There are some remnants of terraced surfaces probably of Pleisto-cene periglacial origin. Some displacements have been individuated, probably active also in recent times. Much of the area's surface shows serious hydrogeological degradation, with numerous and vast landslide phenomena in some places connected with seismic events. Some reports of archeological evidence indicating the presence of man aroused our hopes of finding chronological evidence of this type. The presence of soils allowed a pedological and palinological study and therefore the opportunity of connecting paleoclimatic and paleovegetational references with geomorphological evolution and the possible correlation with other data of the same kind. The investigated area is located on the Adriatic side of the Northern Apennines where formations belonging to the stratigraphic-structural unist of Mt. Modino - Mt. Cervarola, Canetolo and Mt. Caio widely outcrop. Just SSW of the investigated area the «Macigno» Formation, belonging to the Tuscan sequence, is present. In spite of controversial paleogeographic and stratigraphic interpretations, the structural setting of the area can be outlined as follows.
The «Macigno» Formation, represented by thick bedded torbiditic sandstones and marlstone (upper Oligocene-lower Miocene in age) forms an NE overturned anticline, with axis oriented NW-SE. Out of the structural units outcropping in the region this is geometrically the lowermost one.
Overthrusted above the « Macigno » Formation (the highest part of the Tuscan « nappe ») the Mt. Modino - Mt. Cervarola Complex is present. It is represented by thick turbiditic sandstones and marls with several intercalated « olistostromes ». Considerable disagreement exists among Authors regarding the original paleogeographic location of this stratigraphic sequence, which is considered belonging the inner (allocthonous) Tuscan basin by some, or to the external (autochtonous) Tuscan basin by others. Furthermore some German Authors retain that the Mt. Modico - Mt. Cervarola sequences were deposited in a trough located between the Tuscan and Umbrian basin. From a structutal point of view, the Mt. Modino - Mt. Cervarola Unit is characterized by tight folds overturned N ad NE. Normal and reversed faults are present which show Apenninic and antiapenninic strikes.
Geometrically above the Mt. Modico - Mt. Cervarola Unit, formations belonging the Canetolo Unit are present. The latter is considered as deposited between the Ligurian and Tuscan domains, and it is often referred to as a «Subligurid Unit ». Sediments of this sequence are represented by claystones, limestones and sandstones. They outcrop limitedly and with reduced thickness.
Geometrically above the Canetolo Unit, the Mt. Caio Unit is present, which is ascribed by all the Authors to the Ligurian area. It is represented by the well known sequence of the « Helmintoidaea Flysch » (Senonian in age) an by its base complexes. The latter are widely outcropping and are constituted by chaotic claystones with ophiolites (« argille scagliose» Auctt.) and by interbedded claystone and sandstones. The formations of the base complexes are highly tectonized and laminated, while the « Helmintoidaea Flysch » forms several overturned folds with Apenninic vergency which are affected by faults.
Finally, in the NW edge of the investigated area near the Secchia River, the « Burano Formation » outcrops, which is Triassic in age and is constituted by evaporitic rocks (gypsum, anhydrite, dolomitic limestone). It is highly tectonized and it is known both from the Tuscan and Umbrian sequences.
The structural setting briefly reviewed, was reached mainly in the upper Miocece (Tortonian) during the so-called Tuscan phase of the Apennines orogeny, when the above discussed piling of structural units occurred. During the Messinian, Pliocene and Quaternary periods the uplift of the region continued up to the present. Linear features (as normal, reversed and wrench faults) which are particularly evident in the present day morphology, indicate that a recent neotectonic activity has affected the investigated area.
The analysis of thermometric and pluviometric data of the period 1961-1977 has given the following results: the average annual temperature is between 11 ℃ in the valley a reas and 5 ℃ on the hills. Maximum temperature is 34 ℃ in August, the minimum recorded is - 17 ℃ in January. The ave rage annual range of temperature is 15.5 ℃. On the whole the area studied has a rather low continentality index.
The annual amounts of rainfall go from a minimum of 1000 mm to a maximum of 2000 mm. The average annual rainfall is 1700 mm distributed over 117 wet days. The rainiest month is November (226 mm), the dryest July (66 mm). The pluviometric régime of the area studied is of the sub-mediterranean type.
According to the classification of KOPPEN the area is of the Csb type of climate (subcontinental), more precisely, the areas below 800 m are of the continental temperate climate type and those above 800 m are of the cool temperate climate type.
As for the frost-thaw cycle analyses, these are a negligible aspect of the climate up to 700 m, but become more significant at higher altitudes. The snow cover becomes appreciable in the month ol November and disappears almost

completely in May. Maximum thicknesses are achieved in February and March, in places over 1 meter at the highest altitudes. Over 1 000 m altitude, the ground is covered with snow during all the winter period and also during the spring at altitudes higher than 1 200 m.
Data regarding annual maximum rainfall lasting from 1 io 5 days have been elaborated statistically. These data may be conveniently interpreted according to Gumbel's law of extreme values which permits the calculation of the height of the rain with return time T for a duration t from 1 - 5 days. For every station typical parameters of the climatic possibility curves were calculated in relation to the average and to values with a return time of 50 years. Data distribution is represented cartographycally with results obtained from experimental values for the averages and their extrapolation for the return times given.
Lastly, the hydric balance was calculated using THORNTHWAITE's method for the 4 basins in the area studied. The hydrological characteristics of the 4 basin were found to be similar, considering that the area has more or less the same regime as far as rainfall is concerned. The flow coefficient tends to be high everywhere, with annual average values ranging between 0.71 of T. Secchiello and 0,53 of Rio Sologno, the units flows vary between 43 litres per km^2 and 22 litres per km^2.
The geomorphological survey was carried out principally in the field and preceded and followed by a careful photointerpretative study. The map shows the lithologic characteristics of the bedrock, the surface formations, the tectonic and hydrographic data, various genetic types of forms and processes and some forms of mixed origin. As far as the chronological aspect is concerned, the deposits have been related in the upper Pleistocene - present interval; the forms have been related to the Holocene (past and present) with the exception of the glacial and periglacial forms, which have been attributed above all to the Pleistocene, and the karstic forms, which have been considered polychronological. The recent activity of a number of tectonic lines is also depicted. The forms licked to the action of channelled surface waters have been distinguished to show slope forms and stream forms.
Slide phenomena have been divided into three types: flow-sliding fall, massive fall.
From the orographic point of view the most significant elements are the two mountain ridgelines, one (Mt. Cusna - Mt. Ravino) of Apennine orientation, the other anti-Apennine. The former is constituted predominantly by arenaceous rocks and has the alignment characteristics of the highest peaks in an internal position with respect to the main Apennine divide (phenomenon probably due to recent Tectonics). The latter is constituted predominantly by flyschoid formations.
With reference the area can be divided into two morphostructural strips: the upper Apennine strip, and the central Apennine strip. The first strip, characterized by overturned folds and overthrusts, is marked by the following geomorphological characteristics: high-energy relief, steep depression of tectonic origin of the divide, maximum elevation not coincidental with the main Apennine divide. The second strip is constituted by clay and flyschoid formations ,vhich tectonically cover, in part, the units of the first strip and are, in turn, covered tectonically by other units. In this area the clay and flyschoid formations are amply developed and their tectonic setting, often complicated and sometime chaotic, produces very irregular forms due to selective erosion. The morphological processes that have modelled and are modelling the slopes of the are mainly glacial processes, slope processes in periglacial and temperate environments, and torrent-like, karstic and anthropic processes. The evolution of the slopes is occuring at present by the action of diffused and channelled waters and by the actions of mass movements of different types.
A large part of the area has been subjected during the Pleistocene to glacial morphogenesis. Morainic accumulations constituted by chiefly arenaceous detritus modelled into ridges, rounded hillrochs, are observed widely on the slope below the highest peaks exposed to the N and NNE. Chatacteristic cirque forms, more or less preserved and remodelled by successive degradation processes are also due to glacial morphogenesis.
A number of detritic accumulations previously attributed to glacial morphogenesis have been interpreted as glacis deposits. For the most part it is a matter of materials derived from the erosion of moraines and left on the clay slopes downstream of the glacial fronts by plastic fluid movements, particularly active in a cold climate when the hight relative humidity and the abundance of snow favoured a high water content in the soil.
Periglacial morphogenesis has worked widely in the area during the cold phases of the upper Pleistocene. Its action as responsible for soft forms and accumulations which in some cases have completely smoothed the slopes cut earlier. Such forms are connected with intense frost shattering and with slope processes (slope wash due to the melting of snow), which have produced and deposited large detritic accumulations. The most characteristic periglacial forms of the area are the niches cut by nivation and the stratified detritic deposits on slopes (éboulis ordonnés). Other forms due to Pleistocene periglacial morphogenesis are congelifluction deposits. Present periglacial processes shattering congelifluction, pipkrake) are observed only at the highest elevations and where anthropic brush clearing has eliminated spontaneous plant cover.
Torrent-like erosion is actively present throughout the area. The forms connected with it however date chiefly from the Holocece, when the improvement in climatic conditions favoured the reactivation of linear erosion. Steep slopes were thus created which contrasted distinctly with the soft forms produced earlier by periglacial morphogenesis. In some areas the erosion by action of torrents, particularly active, triggers slide phenomena of varying importance on the slopes.
Terraced alluvial deposits due to weathering (cold peaks during the Holocene) or anthropic (brush clearing) causes are found where the particular geomorphological conditions have permitted them to accumulate and to remain.
Relicts of terraced alluvial deposits from the Pleistocene are found in places.
Present morphogenesis on the slopes is linked essentially to the action of flowing surface waters and to the action of gravity. Present geomorphological evolution is different on slopes of lesser gradient modelled by glacial and periglacial processes of the Pleistocene and of those having steep gradients connected for the most part with the resumption of linear erosion in the Holocene. On surfaces of flatter gradient large slide phenomena (of the flowingsliding type) are produced which involve primarily the covering materials or, sometimes, phenomena of plastic deformation and solifluction. The steep slopes, on the other hand, are the site of slide movements (fall and flowsliding) which generally involve the bedrock.. Present on such slopes in a more or less intense manner, moreover, are erosion processes due to flowing surface waters.

The karstic phenomenon appears to be particularly developed on some reliefs corresponding to gypsum-limestone outcroppings of the Triassic. In these formations the phenomenon of dissolution creates sinks, caves, pits, funnels, large springs, etc. Recent studies have demonstrated the presence in the area of numerous alluvial sinks which testify to a widespread and deep karstic activity. A recurrent phenomenon is the clear alignment of the sinks, which probably follows the course of fractures and of small faults.

In the section devoted to the quantitative analysis, the morphometric characteristics of the stream network are considered. To this purpose the whole area is subdivided in the component drainage basins and the relations between drainage density, relief ratio, hypsometric curve, slope angle and lithology are discussed. Slope and aspect maps of the whole area, obtained by automatic data acquisition and processing, are also proposed. After discussing in short the construction techniques, the distribution of the various slope and aspect classes is discussed.

The soils in the Febbio area (RE) may be grouped into three altimetric zones referred to as many thermic regimes: the lower one, un to 1 300 m a.s.l., with a mesic regime; the intermediate one, up to 1 900 m, with a frigid regime and, finally, the higher one over this altitude, presenting a criic regime in soils which have no accumulation of rough organic matter on the surface (SOIL TAXONOMY, 1975). Everywhere the moisture regime is udic.

In the lower climatic zone, on shales, soils with recent and actual pedogenesis are mainly found. The degreee of development does not exceed that of the Entisoils, also because of active erosion; on more stable morphologies, mainly on sandstone, Inceptisoils may develop.

The intermediate zone is the area with the greater accumulations of glacial and slope deposits. Still now there appear evidences of older fluvial, glacial and periglacial cicles.

As to the recently deposited materials and the eroded surfaces, the pedological landscape is linked to the actual evolutive and environmental situation, with the presence of Entisoils, Spodosoils and Inceptisoils; while, where evidence of ancient events may be observed, paleosoils, both relict and buried, are found. Frequent sedimentological, pedological discontinuities and stone lines appear in more stable morphological situations.

The higher zone is dominated by the genetic process of the eluviation of the bases from the system because of the udic regime characterizing the environment. On sandstone lithotypes and on deposits of colluvial material, podzolization is the most expressed evolutive trend of the stable surfaces. On carbonatic lithologies, the evoluviation phenomena are slowed, also because of low temperature (criic regime), and Mollisoils are found. Finally, the evolutive trends appear limited in the situations subjected to erosion and there mainly develop Entisoils and rock outcrops.

The relict soils of the intermediate zone were more carefully studied, by means of chemical, sedimentological and mineralogical analysis, with the aim of building up a chronological scheme of the environmental and geomorphic phenomena that may have been important for soil development. Three homogeneous units were distinguished: the flysch reliefs; the glacial deposits; the paleosurface of Mt. Cusna.

The flysch reliefs still present marks of paleopedogenesis preceding the last glacial period. They are Paleoudalfs developed on glacis deposits and represent the southern and highest sector of a paleopedological facies well documented on the Emilian Apennines and on the terraced alluvial fans of the pedeapennines. During the last glacial period the flysch area was reached by the moraines only during the most ancient phase, while it was later interested by evident phenomena of periglacial sedimentation (éboulis ordonné). On these deposits, during the late glacial period in the Holocene, Haploboralfs developed.

Even in the absence of absolute dating, the principal system of the morainic deposits in Val d'Asta in attributed to the glacial maximum 19000 b.p. old during the last glaciation. In this area, the pedogenesis is, of course, post-glacial: stratigraphic, paleobotanical and palethnological evidence suggests that only during the Atlantic period there were favourable conditions for the devepment of soils presenting peculiar genetic mineral horizons, and representing a typical chrono- and pedo-stratigraphic unit for that age in the studied area.

During the Pre-Boreal, an environmental, perhaps a climatic, crisis caused, the erosion and the burying of those soils with colluvial deposits. The accumulation of organic metter due to a new resettling of the vegetation cover, determined a general brunification and, in particular conditions, a process of podzolization.

The paleosurface of Mt. Cusna, largely glacialized during the glacial maximum, shared with the second area its pedogenetical history up to the Atlantic: in fact all over the paloesurface, Inceptisoils, usually buried, are found.

From the Sub-Boreal un to now, the evolutive phases are completely different. This period is characterized by a strong transport of material from more sloping and higher areas and an accumulation in areas with less energy. In these areas the pedogenesis that develops on the colluvium varies according to the dynamic of the transport: when it is stronger Entisoils are found; where, on the contrary, the colluvium is shallower: Mollisoils may develop.

More recently, perhaps because of anthropic influence (logging and intensive grazing) a strong gully erosion prevailed, disecting the surface into edges separated by channels and deep incisions.

As with a good deal of the ridge areas of the Tuscan-Emilian Apennines, the zone of Febbio was also densely settled during the Boreal and early Atlantic age by mesolithic hunters. At first micro- and hyper micro-lithic triangles and Sauveterre points appear and later a new tradition with trapezes takes place. The mesolithic settlements were located in strategic positions for hunting and harvesting: along passes and edges of lake basins. Ad for the remaining Atlantic period, numerous Neolithic communities settled in the plain in the Po Valley at the foots of the Apennines, whereas the zone of Febbio remained uninhabited. Traces of occasional passages have been recorded in the Sub-Boreal age concerning eneolithic, Iron Age and Roman age cultures. A first systematic exploitation of the area was recorded in the early Middle Ages when some curtensian structures were established in the area. The settlements however began to be properly documented in the Middle Ages when a systematic exploitation of the woods began with consequent sheep-rearing activity. The cultivation of the land on the other hand was restricted to small plots surrounding the family dwellings.

Palynological investigation carried out on the soil profile "Bagioletto" has given the following: preliminary results. Absolute pollen frequencies increase in a downward direction through cyclic oscillations. This vertical pollen distribution occurs also when we consider Pteridophyta or Spermatophyta APF singly. APF oscillations are correlated with lithological discontinuities in soil profile. Pollen analysis appears to confirm pedological investigations: the "Bagioletto" profile consists of two soils; the lower soil has been broken by erosion, the upper one is evolving on a colluvial deposit. A

deeper pollen spectrum of the paleosoil shows local herbaceous environments, bordered by woodland with thermophilous hardwood: Quercus, Ulmus, Carpinus, Ostrya, etc. The following spectrum testifies cooler and wetter condition (Abies, Fagus, and increase of Alnus). In the pollen spectra of the upper soil we found grassland and/or heathland environments in loco and the spread of Fagus in the nearby woodland. By comparison with Chiarugi's diagrams concerning the Apennines we can assume the "Bagioletto" pollen spectra would cover a space of time from the Boreal to Subatlantic period.
The authors outline a schematic description of hydrogeological and structural features of ground-water reservoirs connected with the lithological units represented in the Febbio area. Information about the hydrodynamic behaviour of aquifer and their connection with the drainage network is also given. As well as traditional parameters, such as permeability, presence of fissures and so on, the way ground water circulates has also been taken into account. Therefore, the following distinction has been made: pervious units, semi-permeable units, and impermeable units. Moreover, limits of impermeable and semi-impermeable bodies (forming «septa» that cannot be crossed over by water)and limits between pervious formations (forming relative separation «septa» for circulating waters) have been pointed out. On this ground, the Febbio area has been divided into 4 sectors. It has been also verified the connection between water outflow from more pervios formations next to highly argillaceous units, and development of landslide phenomena pecurialr to many of the considered areas.
To describe the use of resources and the relationship between man and the environment under consideration, a land-use map has been drawn up. This map, useful in many different ways, shows both the qualitative characteristics of the information (type of use) as well as those of a distrubutional and dimensional nature. The area has been divided into 17 classes of use.
The recontruction of the area's geomorphological evolution is as follows:
The most ancient traces of morphogenesis seem to be provided by some remnants of summit surfaces and in particular, that of M. Penna.
In the, Mt. della Stetta locality traces of surfaces have been found dating back to the penultimate glaciation, with evidence of paleopedogenesis from the last interglacial period.
Before the last glaciation there must have been a phase of erosion carving out the valleys which would contain the glacial tongues and moraine and periglacial deposits.
The glacial and periglacial morphogenesis of the last cold Pleistocene period has left the most evident traces in the area in the form of erosion and deposits, in places very clear and well preserved: for example, the moraine deposits of Mt. Della Stetta, Governara and Mt. Cusna, the periglacial stratified slope deposists of the «éboulis ordonnés» type, on the slopes of Mt. Prampa and Mt. La Stetta, and the glacis deposits in front of the moraine heaps.
The morphoclimatic conditions brought about by the last glaciation and, in particular, those of the last apex would markedly inhibit pedogenetic processes.
In a decisively post-glacial period the are becomes covered by forest up to the highest altitudes and the environmental conditions become favourable to the settlement of Mesolithic communities. From the Sub-Boreal period onwards the environment acquires more outstanding, dynamic elements connected with a deterioration in the climate: a widespread phase of colluvium accumulation affects all the environments examined and this is followed by a phase of marked, prevalently linear incision. This phenomenon may be justified by both the strong neotectonic activity in the area and by the deterioration of climate with the Sub-Atlantic period.
These neotectonic movements are responsible for the raising of the Monte Cusna chain - the Alpi of Vallestrina, which, as a result, is situated above the Apennine watershede.
With the regrowth of vegetation on the slopes during the Boreal period and with the consequent reduction in the quantity of débris material introduced into the hydrographic system, in the main drainage system, there is a connection with an active phase of vertical erosion which first carves out the deposits accumulated during the previous phase and afterwards the whole substratum. Connected to this linear erosion there are, of course, instances of instability often producing landslide phenomena.
In more recent times the spreading practice of deforestation has produced widespread slope-instability with resulting erosion of the soils and more generally, of the slopes.

RIASSUNTO: GRUPPO RICERCA GEOMORFOLOGICA CNR, Geomorfologia del territorio di Febbio tra il M. Cusna e il F. Secchia (Appennino Emiliano) (IT ISSN 0084-8948, 1982).
I motivi scientifici che hannno portato alla scelta di quell'area per uno studio interdisciplinare sono i seguenti: vi sono numerose testimonianze del glacialismo quaternario, sotto forma soprattutto di accumuli morenici; sono presenti alcuni lembi di superfici terrazzate di probabile origine periglaciale pleistocenica; sono state individuate alcune dislocazioni probabilmente attive anche in tempi recenti; molte parti del territorio si presentano in grave dissesto idrogeologico, con numerosi e vasti fenomeni di frana, a luoghi anche connessi con episodi tellurici; alcune segnalazioni di testimonianze archeologiche di frequentazione umana facevano sperare in un supporto cronologico di questo tipo; la presenza di suoli poteva permettere un approfondimento pedologico o palinologico e quindi la possibilità di riferimenti paleoclimatici e paleovegetali all'evoluzione geomorfologica e l'eventualità di correlazioni con altri dati dello stesso tipo.
L'assetto strutturale della regione è legato alla fase principale della tettogenesi dell'Appennino che risale al Tortoniano (fase toscana) con sollevamenti che continuano anche fino al Quaternario con pulsazioni di varia durata ed intensità.
In base alla classificazione di KOPPEN l'area studiata si inserisce nel tipo di clima Csb (subcontinentale), più esattamente le località al di sotto degli 800 m sono del tipo a clima temperato continentale, quello sopra gli 800 m del tipo a clima temperato fresco. Sono stati analizzati i dati termometrici e pluviometrici, i cicli di gelo e disgelo, le precipitazioni massime annuali da 1 a 5 giorni di durata e infine è stato fatto il calcolo del bilancio idrico, utilizzando il metodo THORNTHWAITE, dei quattro bacini presenti nell'area.
L'area è stata soggetta, durante il Pleistocene superiore, a morfogenesi glaciale e periglaciale. Caratteristiche forme a circo e accumuli morenici si osservano sui versanti posti a ridosso delle cime più elevate ed esposti verso Nord. Le

forme periglaciali più significative sono le nicchie di nivazione, i detriti stratificati di versante (éboulis ordonnés) e i depositi a glacis. Processi periglaciali (gelifrazione, geliflusso, pipkrakes) si osservano oggi solo alle quote più alte e dove il disboscamento antropico ha eliminato la copertura vegetale spontanea. La morfogenesi recente e in atto è connessa con le azioni delle acque correnti superficiali (erosione torrentizia, ruscellamento diffuso e concentrato) e della gravità (movimenti di massa di diversa tipologia e importanza). Il carsismo ha prodotto caratteristiche forme in corrispondenza degli affioramenti gessoso-calcarei del Trias.

Uno studio specifico è stato dedicato all'analisi geomorfica quantitativa per evidenziare le caratteristiche morfometriche del reticolato idrografico, dell'acclività e dell'orientamento dei versanti, anche mediante i mezzi automatici di rilevamento ed elaborazione dei dati.

I suoli dell'area di Febbio possono essere raggruppati entro tre fasce altimetriche riferibili ad altrettanti regimi termici. La fascia inferiore, sino a 1 300 m s.m., con un regime mesico; quella intermedia, sino a 1 900 m s.m. con un regime frigido; la fascia superiore con un regime critico. Sono stati presi sotto particolare studio, con analisi chimiche, sedimontologiche e mineralogiche, i suoli relitti della fascia intermedia, nel tentativo di costruire uno schema cronologico dei fenomeni geomorfici ed ambientali che possono aver influito sullo sviluppo pedogenetico dei suoli. Sono state distinte alcune unità omogenee: i rilievi del flysch, i depositi morenici, la superficie del M. Cusna. I rilievi del flysch conservano tracce di paleopedogenesi precedente l'ultimo periodo glaciale; durante il glaciale l'area venne raggiunta dalle morene soltanto nella fase più antica, mentre fu sede poi di evidenti fenomeni di sedimentazione perigliciale (éboulis ordonnés); su tali depositi, nel Tardiglaciale e dell'Olocene, si evolvono degli Haploboralfs. Depositi morenici sono attribuiti all'apice gliciale dei 19 000 anni b.p., con pedogenesi postglaciale; una crisi ambientale causa nel Preboreale l'erosione ed il seppellimento dei suoli da parte di depositi colluviali, mentre un nuovo ristabilirsi della copertura vegetale determina una successiva brunificazione. La superficie del M. Cusna ampiamente glicializzata durante l'apice glaciale, condivide con la zona morenica la storia pedogenetica fino al periodo atlantico; dal periodo subboreale in poi è invece caratterizzata da una forte asportazione di materiali dalle zone più acclivi e più alte in quota e di accumulo nelle zone di minore energia di rilievo, con una pedogenesi che porta a Entisuoli e Mollisuoli.

Per quanto riguarda le testimonianze archeologiche e storiche della frequentazione umana, l'area è stata fortemente insediata durante il Boreale e l'inizio dell 'Atlantico da cacciatori mesolitici con industrie litiche di tipo sauvterroide e tardenoide; poi rimane deserta, con passaggi occasionali nell'età del ferro e romana; un primo sfruttamento sistematico dell’area è documentato nel tardo alto Medioevo, ma è soltanto nel basso Medioevo che inizia il sistematico sfruttamento del bosco e la conseguente pastorizia, mentre la coltivazione del terreno rimane limitata a piccoli appezzamenti immediatamente circondanti i nuclei abitati.

Il diagramma pollinico del profilo « Bagioletto » sembra interessare un lasso di tempo che va dal Boreale al Subatlantico.

Sono stati allestiti uno schema idrogeologico e una carta della utilizzazione del suolo.

La ricostruzione dell'evoluzione geomorfologica dell'area è la seguente. Le più antiche tracce della morfogenesi sembrano essere costituite da alcuni lembi di superfici sommitali ed in particolare quella del M. Penna. Tuttavia in località M. Stetta, sono state trovate tracce di superfici, con indizi di una paleopedogenesi dell'ultimo interglaciale, connesse con la faso di resistasia del penultimo glaciale.

La morfogenesi glaciale e periglaciale dell'ultimo periodo freddo pleistocenico ha lasciato nell'area le tracce più vistose, consistenti in forme di erosione e di accumulo, a luoghi molto evidenti e ben conservate. I depositi morenici di Governara e di M. Stetta sono stati attribuiti ad uno stadio Primiglaciale dell'ultimo periodo glaciale; quelli fra i 1100 e 1 300 m del M. Cusna, gli éboulis ordonnés di M. Prampa e M. Stetta e i glacis di Febbio e di Casalino (in parte) sono stati riferiti, invece, al Pleniglaciale; il morenico più elevato del Cusna ed una parte del glacis di Casalino sono stati infine ascritti al Tardiglaciale. Anche in questo periodo, come in tutto l'ultimo glaciale, le condizioni morfoclimatiche hanno fortemente rallentato i processi pedogenetici. Si fanno risalire infatti al Tardiglaciale l'inizio dell'evoluzione del profilo del Prampa e del profilo di Corni Piccolo II.

Si suppone che, alla fine del Tardiglaciale, in un quadro di progressivo miglioramento climatico, le superfici originate precedentemente, siano andate gradualmente coprendosi di vegetazione. Nel Borealeeo nell'Atlantico ha luogo nell'area una fase di pedogenesi prevalente. Dal Subboreale in poi l'ambiente acquista più spiccati elementi di dinamicità connessi ad un deterioramento climitico, documentato nelle spettro pollinico di M. Bagioletto: una diffusa fase di colluvionamento interessa tutti gli ambienti presi in esame, ad essa segue una fase di forte incisione prevalentemente lineare. Tale fenomeno deriva sia dalle persistenti condizioni climatiche di umidità, che dalla forte attività neotettonica dell'area.

In tempi più recenti il diffondersi della pratica del disboscamento e della pastorizia intensiva ha prodotto diffusi squilibri, con conseguenti processi di erosione dei suoli e più in generale dei versanti.