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Original article

Sedimentology, palynology and new geochronological constraints on Quaternary deposits of the Corvaro intermontane basin (central Italy)

Sédimentologie, palynologie et nouvelles contraintes géochronologiques des dépôts quaternaires de la vallée intramontagneuse de Corvaro (Italie centrale)

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Abstract

Two main depositional phases are recognized in the Middle-Late Pleistocene sedimentary sequences of the Corvaro tectonic depression (Latium, central Italy). To improve the chronological, palaeoenvironmental and palaeoclimatic frame of the area two boreholes were drilled. They allowed to estimate the thickness of deposits, to define the stratigraphy and to establish the presence, during the second phase, of a palustrine/lacustrine environment limited to the marginal sector of the Amara valley alluvial fan.

The Corvaro 2 core was palynologically investigated. Pollen of nonarboreal plants dominates the assemblages, suggesting that a steppe characterized the environment during a glacial phase. Pollen of arboreal plants is scarce, and represented mainly by gymnosperm trees and shrubs. A slight expansion of deciduous oaks together with sparse occurrences of some other mesophilous trees is radiocarbon dated at around 30,000 years BP. These arboreal oscillations of the last glacial period are found for the first time in a mountain area of the Apennine region. Our results suggest that intermontane valleys, such as Valle del Salto, have probably played an important role in preserving biodiversity.

Résumé

Deux phases principales de déposition ont été identifiées dans la séquence sédimentaire de la dépression tectonique de Corvaro (Latium, Italie centrale), pendant le Pléistocène moyen et supérieur. Afin de mieux cerner le cadre chronologique, paléoenvironnemental et paléoclimatique de cette région, deux forages ont été réalisés. Ils nous ont permis d'évaluer l'épaisseur des dépôts, de définir la stratigraphie et d'établir la présence, pendant la deuxième phase de dépôt, d'un environnement lacustre/palustre. La carotte Corvaro 2 a été l'objet d'une analyse pollinique. Le pollen de taxons herbacés domine le diagramme et cela suggère que la steppe caractérisait la végétation de ce site pendant une période glaciaire. Le pollen des taxons forestiers s'est révélé rare et est représenté essentiellement par des gymnospermes et des arbustes. La faible présence de chênes à feuilles caduques et l'existence sporadique d'autres arbres mésophiles ont été datées aux environs de 30 000 années BP. Ces oscillations enregistrées lors du dernier âge glaciaire ont été observées pour la première fois dans une zone de montagne des Apennins. Ces résultats suggèrent que les vallées intermontagneuses, tel que la Valle del Salto, ont probablement joué un rôle très important dans la conservation de la biodiversité.

Keywords: Quaternary; Intermontane basin; Stratigraphy; Palaeoclimate; Palynology; Central Italy

Mots clés : Quaternaire ; Vallée intramontagneuse ; Stratigraphie ; Paléoclimat ; Palynologie ; Italie centrale

1. Introduction

The Servizio Geologico d'Italia (currently APAT, Dipartimento Difesa del Suolo) has recently carried out studies for the production of sheet n. 367 "Tagliacozzo" (central Italy) of the Geomorphological Map of Italy at the scale 1:50,000. The stratigraphic analysis of the continental Quaternary deposits, which

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fill the intermontane basins, has been crucial in understanding the geological and geomorphological evolution of the area.

Researches on Apennine intermontane basins, often concern tectonic and geomorphological aspects, but are generally missing of palaeobiological data. To begin filling this gap, the reconstruction of the environmental, climatological and chronological framework of the Corvaro plain (Rieti, central Italy) during the Pleistocene and Holocene was planned, and carried out on two long cores through a multidisciplinary research involving sedimentology, palynology and geochronology.

The new data on the environmental history of the central Apennines mountain region were compared with the well-known vegetation evolution of the hilly volcanic region of Latium (e.g., Follieri et al., 1998).

2. Geological and environmental framework

Uplift and extension of the central Apennines since the Upper Pliocene-Early Pleistocene created numerous Pleistocene intermontane basins, which were then filled with alluvial and lacustrine deposits (D'Agostino et al., 2001). These appear to be limited by normal faults, which are in general located along the northeastern flanks of valleys (Galadini and Messina, 2004). A summary of stratigraphic data on the main intermontane basins and a comparison of their geological evolution is available in Bosi et al. (2003).

The asymmetric tectonic depression of Corvaro is located in northern Latium, on the western side of the Apennine watershed. It is imposed on the Meso-Cenozoic carbonate bedrock of the "laziale–abruzzese" platform. The evolution of the basin is related to the Quaternary activity of a fault system that crops out along the southwestern side of Monte Velino–Monti della Duchessa (Fig. 1). This activity probably began in the Early Pleistocene after the deposition of the oldest fluvial and lacustrine succession during the Late Pliocene–Early Pleistocene.

Late Pleistocene–Holocene tectonic movements (Giraudi, 1994) are indicated by the displacement of both cemented slope debris on the fault footwall and, with limited throw, of deposits filling the basin. However, a preliminary analysis of the remnants of old erosion surfaces found on both the carbonate bedrock and on early continental deposits concludes that the most significant tectonic activity ended essentially during the Middle Pleistocene (Chiarini et al., 1997).

The enormous quantities of coarse debris produced and mobilized during the Quaternary glaciations left a strong influence on both local relief and stratigraphy (Cassoli et al., 1986). They form the alluvial fan systems of the Teve–Ruara valleys on the southeast of the plain and of the Amara valley to the northwest.

Geological and geomorphological studies carried out for the production of the geomorphological sheet (Servizio Geologico d'Italia, in press) have identified two main phases in the depositional architecture of these alluvial sediments. In the first phase, both the Teve–Ruara and Amara valley sediment supplies formed aggradational stacked sequences (Cartore unit) confined to the intermontane basin. The Cartore unit crops out mainly in the southeastern sector of the depression where it forms an alluvial fan. The proximal and medial sectors of this alluvial fan are characterized by coarse grained, weakly bedded or unstratified, and poorly sorted sediments typical of bed load transport and debris flow. On the margins of the alluvial fan, there are braided stream facies including bar sequences and fine overbank flood sediments. On the northwest side of the Corvaro plain, the Cartore unit has been eroded and covered by younger deposits.

Before the second phase in the southeastern sector of the depression, the Teve–Ruara drainage system was diverted to the southwest towards the Salto valley. As a consequence, telescopic alluvial fans aggraded outside the Corvaro basin as far as the Torano area. Various sequences of aggradation, divided by minor disconformities, can be recognized. These are shown in a single colour in Fig. 1 (Ruara valley units). To the northwest of the Corvaro plain, on the other hand, sedimentation in the Amara valley drainage system continued partly within the basin because of subsidence of this sector relative to the southeastern one. This sedimentation formed the Amara valley unit.

Geomorphological and stratigraphical considerations show that the deposits filling the Corvaro basin are younger than a pyroclastic sediment cropping out at the head of the Ruara valley. $^{40}Ar/^{39}Ar$ dating carried out on a small amount of feldspar of this volcanic deposit provided a range of apparent ages comprised between 0.53 and 0.74 Ma due either to alteration of minerals or possible presence of xenocrysts (M. Laurenzi, CNR-IGG Pisa, personal communication).

The present-day climate varies a lot in few kilometres, from the bottom (799 m a.s.l.) of the Corvaro plain up to the mountains tops, sometimes exceeding 2000 m a.s.l. In particular, Corvaro is at the border between two different thermotypes (Blasi, 1994): the montane inferior thermotype and the hilly superior thermotype. The first one is characterized by mean annual precipitation over 1250 mm, absence of summer aridity, and mean temperature of the coldest month below 0 °C; the second one by mean annual precipitation over 1150 mm, slightly marked or absent summer aridity, and mean temperature of the coldest month between −1.8 and 1.5 °C.

The vegetation presents a high variability being strictly related to geomorphological and climatic features. The forest vegetation of the area (Petriccione, 1993) is mainly constituted by mixed woods with prevailing beech (*Fagus sylvatica* L.), or deciduous oaks (mainly *Quercus pubescens* Willd. and *Q. cerris* L.), or hop hornbeam (*Ostrya carpinifolia* Scop.). Rare trees of *Betula pendula* Roth are found in Val di Teve (few km east from Corvaro). In the same valley elements of evergreen arboreal vegetation (*Quercus ilex* L.) are found on sunny and rocky slopes.

3. Studied material and new geochronological data

Two boreholes, 108 (Corvaro 1) and 35 m (Corvaro 2) deep, were drilled in order to characterize the alluvial deposits of the Cartore and Amara valley units referable to the two phases of deposition mentioned earlier (Fig. 2). Although the drillings did not reach the bedrock, interpretation of geophysical data, kindly provided by the province of Rieti, together with the borehole data indicates that the depositional centre of the basin is at a depth of more than 300 m.