Provenance and Depositional Environment of the Colombacci Formation (Miocene) in the Northern Apennines, Umbria-Marche Region, Italy

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Introduction

This is a study of the depositional environment and provenance of a measured section of the Colombacci Formation (Miocene) near the town of Serrapetrona, Italy. The Northern Apennines are a fold and thrust belt that formed during the Eocene-Pliocene collision between Italy and the Corsica-Sardinia microplate (Alvarez, 1991). This small fold and thrust belt is still active. Geologists have been attracted to the area for hundreds of years due to the major contributions to geology that have occurred in this mountain range, as well as for the sequence of sedimentary rocks exposed in the folds of these mountains. These rocks are well-dated and continuous, spanning the upper Triassic to the upper Miocene. The area has been tectonically active and the folds contain a record of the timing and nature of the Tertiary contractional tectonics that have occurred here (Alvarez and Montanari, 1988).

Although the deposits of the Colombacci Formation have been described frequently in regional studies, very little sedimentological work has been done (Farabegoli and Ricci-Lucchi, 1973; Centamore et al., 1976 in De Feyter and Molenaar, 1984). This study examines the provenance and depositional environment of the Colombacci Formation near the town of Serrapetrona, Italy. A single stratigraphic column was constructed just outside of the town and rock samples were collected at various horizons within the column to aid in the study. By examining the data collected, it appears that the depositional environment of the Colombacci Formation (Miocene) was fluvial. Fining-upward sequences indicate that sediment was deposited in a series of cycles that were probably related to tectonism of the source area due to the fact that the area was tectonically active during time of deposition. This information may aid in answering some questions regarding sedimentary transport mechanisms and depositional processes of the Colombacci Formation of the Northern Apennines (De Feyter and Molenaar, 1984).

Methods & Data

Figure 1 shows the stratigraphic column that was measured and described for the study. A total of 58.80 m was measured, while samples were collected at various levels. Special note of certain sedimentary structures and other information pertinent to the study was also recorded. In carrying out a provenance study for this section, samples were collected and analyzed to determine the relative mineralogical composition of these rocks. Thin-sections were made of these samples so that they could be analyzed in greater detail under the microscope. The method of point-counting was utilized to determine the composition of these rocks. The relative compositions of the samples was determined using this method and the results can be seen in Table 1. Quartz was by far the most abundant component of these sandstones, with minor amounts of micas and relatively little feldspar. Because quartz is the most common detrital mineral in arenites, and because it is virtually the only one in mineralogically mature arenites, subvarieties have been distinguished for both descriptive and interpretive purposes (Lewis and McConchie, 1994). The quartz from this studied section was analyzed in greater detail and was found to contain some fluid inclusions. Polycrystalline quartz was also present in the samples collected. These features were used to distinguish between different genetic varieties of quartz (after Folk, 1980).

Interpretations

Provenance. Because of the presence of the polycrystalline quartz found in the samples, a metamorphic source area is likely for the sediments. Metamorphic quartz is often indistinguishable from primary plutonic igneous quartz. The most obvious metamorphic quartz grains are of the polycrystalline variety. The majority of quartz grains do not have any clear characteristic indicative of their origin and most likely have a plutonic igneous/metamorphic ultimate source, but there is the possibility that they may have been recycled (Lewis and

McConchie, 1994). This common quartz type was found in the samples, but a metamorphic source is more probable than an igneous plutonic source based on the polycrystalline quartz that was found.

Another area of support for a probable metamorphic provenance for the sediment is the presence of specific types of minerals found in the samples collected. Certain mineral assemblages that are found together can be good provenance indicators. The types of minerals that occur in the presence of other minerals are useful in distinguishing between a sedimentary, metamorphic, or igneous provenance. Lewis and McConchie (1994) have described these three types of provenance and the mineral assemblages likely to be found within each one. A high-rank metamorphic provenance is described as including the following minerals: schist/gneiss fragments, muscovite, biotite, chlorite, feldspars, quartz, and such heavy minerals as garnet, epidote/zoisite, staurolite, zircon, sphene, magnetite/ilmenite, and kyanite/sillimanite/andalusite. Although the samples collected for the study did not contain all of these minerals, the minerals that were found by point-counting fit into this group, leading to the interpretation of a metamorphic provenance.

Depositional Environment. The depositional environment of the Serrapetrona section was a fluvial one. Evidence for this lies in the sedimentary structures that were observed at the section, which include the following: channels, ripples, and convoluted bedding. Because the section was not found to contain characteristics that would classify it as a braided or meandering stream, the Serrapetrona section appears to represent the model proposed for an anastomosing stream based on the stratigraphy and sedimentology. The recognition of this type of stream channel has emerged during recent years and is a type that is distinct from braided and meandering stream systems. However, there are relatively few documented examples of modern anastomosed rivers (Smith, 1983 in Walker, 1984) and even fewer ancient examples (Putman and Oliver, 1981 in Walker, 1984). These streams differ from braided sandy rivers by having stable channel patterns and abundant areas in which fine-grained sediment is preserved and deposited, which is what was found with the studied section. Anastomosed streams consist of several or many active channels of high to low sinuosity and unlike braided and meandering streams, they are relatively stable in position. Although an anastomosing model is proposed for the Serrapetrona section, relatively few ancient river systems have been interpreted as anastomosing. Because of this reason, it is premature to propose a general anastomosed fluvial model on the basis of so few modern examples. However, it is important to keep in mind that this type of stream may help to explain or interpret as-yet-undescribed ancient examples that do not fit braided or meandering characteristics, which is what appears to be the case in this study (Walker, 1984).

Tectonism. Tectonic uplift of the source area during the time of deposition also appears to be responsible for the six fining-upward sequences that were found within the measured section. During late Miocene time, this area of the Apennines was tectonically active and sedimentation occurred in a few distinct basins resulting from synsedimentary tectonics. Sediments of the Messinian Colombacci Formation accumulated in these basins and owe their development to an area of high relief that was caused by synsedimentary folding (De Feyter and Molenaar, 1984). Because of the fining-upward sequences that were found and the fact that the area was tectonically active at the time, it appears that there were several cycles of uplift of the source area, resulting in coarser-grained sediments being shed and fining as erosion occurred, which leveled down these uplifted areas. This process repeated itself a number of times, which led to the fining-upward sequences that are found at the Serrapetrona section.

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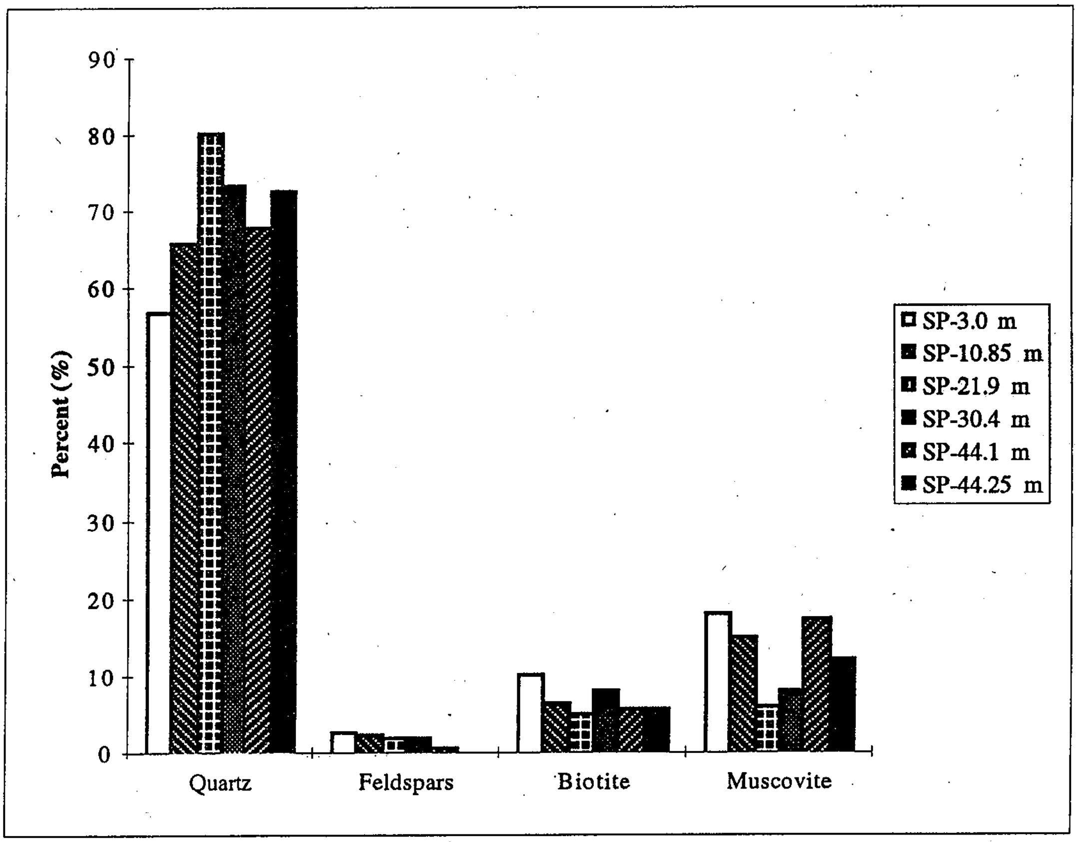

Table 1. Relative compositions of rock samples collected near Serrapetrona, Italy.

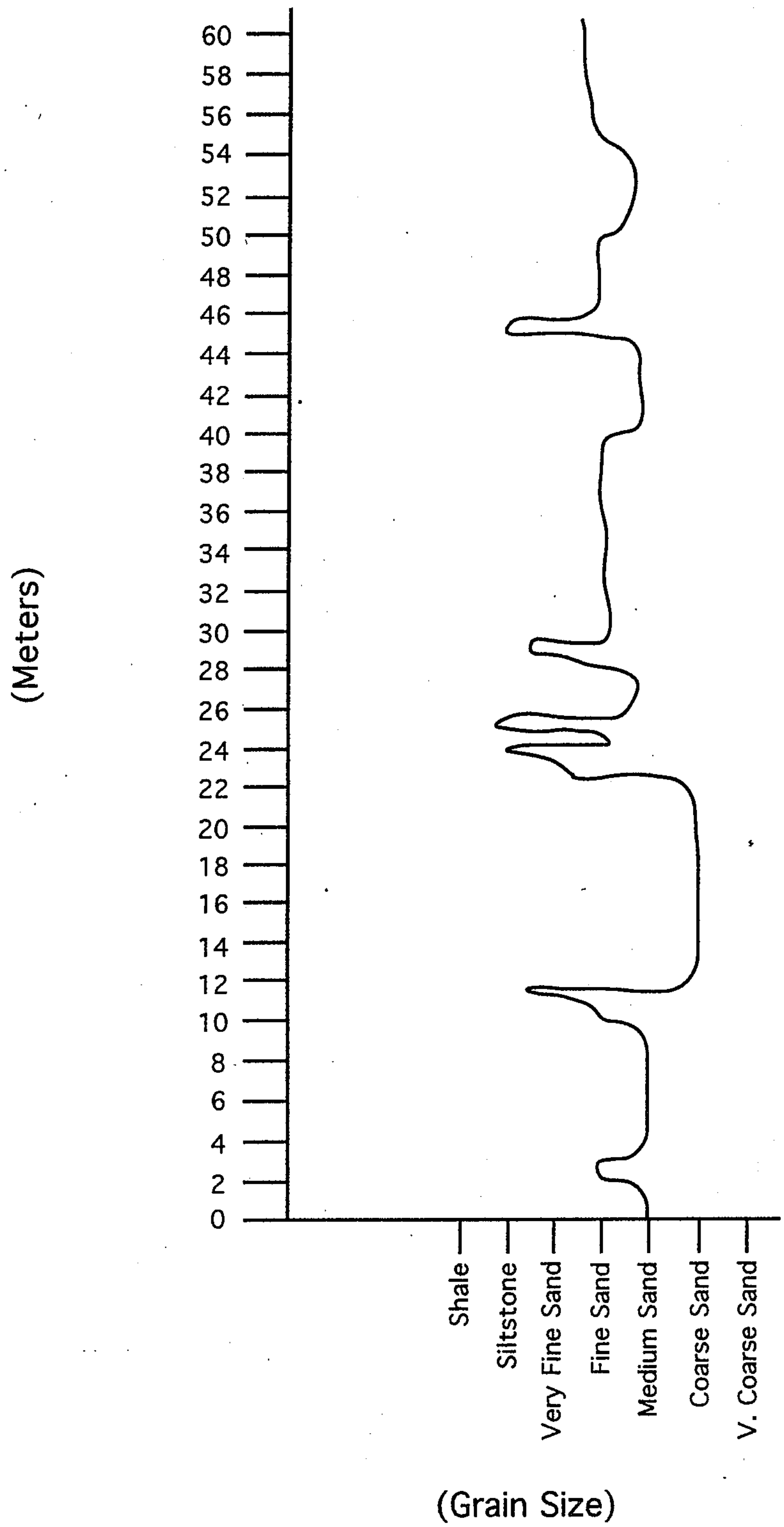

Figure 1. Stratigraphic column showing grain size variations in section measured near Serrapetrona, Italy. All lithologies are siliciclastic.