POLSKIE TOWARZYSTWO MINERALOGICZNE – PRACE SPECJALNE
MINERALOGICAL SOCIETY OF POLAND – SPECIAL PAPERS
Zeszyt 23, 2003; Volume 23, 2003

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# PROVENANCE OF CLASTIC MATERIAL OF SANDSTONES OF THE S.C. CIECHOCINEK BEDS (LOWER JURASSIC) IN THE CZĘSTOCHOWA-WIELUŃ REGION (SW POLAND)

## INTRODUCTION

The purpose of the study is to recognize the provenance of clastic material of sandstone intercalations within the Ciechocinek Beds outcroping at the Silesian-Kraków Upland. Early Jurassic (late Pliensbachian – early Toarcian) Ciechocinek Beds are silty-clayey deposits, distinguishing from other Liassic deposits in their characteristic greenish hue. They consist of poorly lithificated claystones, mudstones and siltstones with irregular, lenticular sand and sandstone interbeds, interpreted as brackish water sediments deposited in a shallow epicontinental sea (Pieńkowski 1997, Leonowicz 2002).

In the purpose of the provenance interpretation sandstones were studied for their mineral composition and properties of quartz grains by using methods proposed by Basu et al. (1975) and Dickinson et al. (1983).

## METHODS

Dickinson et al. (1983) demonstrated that standard QFL and $Q_mFL_t$ diagrams for plotting framework modes of sandstones can be used for the provenance interpretation of detrital material in relation to tectonic setting. Basu et al. (1975) showed that four parameters of detrital sand-size quartz: (a) amount of undulatory quartz, (b) amount of non-undulatory quartz, (c) amount of polycrystalline quartz and (d) number of crystal units per single polycrystalline grain, are useful for discrimination of sands of plutonic, low-rank and high-rank metamorphic parentage.

According to principles of those methods 18 samples of sandstones and 5 samples of sandy siltstones from exposure in Kozłowice and 12 drill-cores were sectioned and point-counted using the Gazzi-Dickinson method (Ingersoll et al. 1984). For each thin section 300 points were counted, taking into account following categories of grains: stable quartzose grains – Q (including monocrystalline quartz grains: $Q_m$ and polycrystalline quartzose lithic fragments: $Q_p$), feldspar grains – F and unstable lithic fragments - L. Undulosity in quartz grains (undulatory quartz: $Q_u$, non-undulatory quartz: $Q_n$) and number of crystal units per single polycrystalline quartz grain (2-3 crystal units per grain: $Q_{2-3}$, more than 3 crystal units per grain: $Q_{>3}$) were also observed and counted. Presence of other components, such as micas and heavy minerals were noted, however they were not counted.

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In addition five samples of unconsolidated sands from exposure in Kozłowice were sieved to extract grains between 0,1 and 0,125 mm in diameter and heavy minerals were separated from them by gravity settling in bromoform. Heavy fraction were impregnated, sectioned and identified. For each thin section 600 points were counted.

## RESULTS

Analysed sandstones are fine- and very fine-grained quartzose arenites and subarkoses (sensu Pettijohn et al. 1973). The major component of their framework is quartz (76 – 94%), which occurs as both, mono- and polycrystalline grains ($Q_m$ and $Q_p$). Quartz $Q_m$ is more common than quartz $Q_p$ but the amount of the latter is also large (14 – 36%). Besides, up to 35% of the quartz $Q_p$ contains more than 3 crystal units per grain ($Q_{>3}$). Non-undulatory quartz ($Q_n$) is more abundant (58 – 83%), but the amount of quartz $Q_u$ is relatively large (17 – 42%).

Other detrital components of sandstones are: K-feldspars (showing usually advanced kaolinization), micas (mainly muscovite; strongly chloritizated biotite is less common), scarce plates of green chlorites, heavy minerals and unstable lithic fragments - L). The most common lithic clasts are fragments of sedimentary rocks: mainly cherts, rarely mudstones, siltstones and quartzose sandstones, and metamorphic rocks: quartzites, mica schists and quartz-mica schists. Fragments of volcanic rocks appear occasionally.

Heavy minerals suite is not diversified. It consists of components, which belong to the most resistant to weathering: zircon, rutile and turmaline. Staurolite and garnets are also common. Simultaneously in 2 samples biotite and chlorite plates were observed. Almost all minerals occur as several morphological types differing in shape and roundness. The most common are: euhedral forms, angular fragments and well-rounded oval grains.

Analysed sandy siltstones have similar mineral composition of detrital framework and differ from sandstones mainly in a grain size.

## PROVENANCE OF DETRITAL MATERIAL

### Source rocks

Comparing properties of quartz grains with criterions presented by Basu et al. (1975) it can be stated that clastic material of studied sandstones are mainly of middle- and high-rank metamorphic parentage. However, taking into account the fine fraction and compositional maturity of deposits, it is very probable that amount of polycrystalline and undulatory quartz was originally higher and the presence of low-rank metamorphic rocks in a source area is likely. Contribution of plutonic rocks was also possible. Composition of lithic fragments and heavy minerals suite confirms such interpretation.

### Tectonic setting of source area

Framework modes plotted on QFL and $Q_mFL_t$ diagrams (Dickinson et al. 1983) point to quartzose recycled orogenic provenance of studied sandstones. The compositional maturity of deposits, presence of different morphological types of heavy minerals and occurrence of the most resistant to weathering components together with biotite and chlorite lead to the conclusion that the detrital material had to be redeposited several times.

**Interpretation of source area setting**

During Late Pliensbachian-Early Toarcian time the Polish part of epicontinental sedimentary basin was bordered to the south-west by Sudety and Silesian-Kraków Land (Deczkowski, Franczyk 1988), where various metamorphic and clastic rocks were exposed. It is the most likely that those rocks supplied detrital material forming studied sandstones of the Ciechocinek Beds. For the first time detrital material could be redeposited in Variscian cycle, when clastic rocks of the Upper Silesian area were deposited. Next stages of redeposition could occur in Late Triassic and beginning of Early Jurassic time, when clastic sedimentation persisted in different continental environments of the Silesian-Kraków area.

The research work was supported by Faculty of Geology, University of Warsaw.

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