Miospore zonation of the Mississippian in the Eastern and Midwest U.S.A.

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No miospore zonal scheme exists in the U.S.A. comparable to that in Western Europe, though parts of the European scheme have been successfully applied in several instances. Most of the successions discussed are located in the Eastern Interior Basin (EIB) and the Appalachian Basin (AB). The ages of miospore occurrences from the former basin, especially those from the Mississippi Valley, are generally well-constrained by independent faunal and microfaunal evidence but the miospore succession is fragmented by numerous barren intervals in this carbonate-dominated sequence. The miospore succession from the AB is represented by well-preserved assemblages from extensive clastic intervals but independent evidence of age is typically scarce.

Kinderhookian, Osagean and Meramecian assemblages from the AB (Kentucky, West Virginia, Pennsylvania and Ohio) closely resemble assemblages of similar age from Western Europe, and the European zonation can be applied with some modification. However, assemblages of this age from the Mississippi Valley (Missouri, Illinois, Indiana and Iowa) differ considerably in composition, with many key taxa absent, or appearing later than in regions to the east. For example, the first appearance of *Lycospora pusilla* in the Mississippi Valley is in the Chesterian (Late Visean) compared with the base of the Visean in Europe.

A provisional, composite miospore zonation is presented for the Mississippian of the EIB and AB though this includes significant gaps. Where applicable, Western European zones are used, but often with redefined basal definitions. Where assemblages differ substantially in composition from Western European assemblages, new zones are tentatively proposed.

Keywords: Mississippian, miospores, zonation, Appalachian Basin, Eastern Interior Basin, U.S.A.

Palynostratigraphic importance of the Strunian in the Iberian Pyrite Belt

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The Iberian Pyrite Belt (IPB) is an important VMS base metals province, with giant massive sulphide deposits such as Neves Corvo Aljustrel (Portugal), Rio Tinto and Tharsis (Spain).

Stratigraphically is composed of two major units, the Phyllite Quartzite Group (PQG) and the Volcanic-Sedimentary Complex (VSC). The PQG is dated as lower Givetian-Strunian by ammonoids and palynomorphs and forms the detrital basement. The PQG consists of phyllites, quartzites, quartzwackes

and shales with intercalations of limestone lenses and nodules at the upper part of the unit which were laid down in a marine siliciclastic platform. The thickness is in excess of 200 m. The VSC is dated as Late Devonian to late Viséan mainly based on palynomorphs. The VSC incorporates several episodes of bimodal volcanism, with dominant rhyolites and dacites, with minor basalts and acessory andesites, and intercalations of black shales, siltstones, minor quartzwackes, siliceous shales, jaspers and cherts and a purple shale formation at the upper part. The thickness is variable (few tens of meters to more than 1000 m). The VSC was laid down in a submarine environment. Overlaying the VSC are the late Visean-Moscovian turbidites of the Baixo Alentejo Flysch Group.

Palynostratigraphic research programs, some developed in collaboration with the mining and exploration companies operating at the IPB, allowed the dating of the sediments of the VSC, that host the massive sulphide deposits and related stockwork structures. Research is based on detailed palynomorph study and characterization of the miospore biozones. The key horizons are dark grey and black shale units that host stockwork and massive sulphide ores in several deposits, e.g., Neves Corvo, Lousal, Caveira and Montinho in Portugal. In Spain similar data was obtained at Alznalcollar and Tharsis deposits.

At the Lousal old mine, recent investigation of two exploration boreholes (LS0801 and LS0802), allowed the identification of the LN Miospore Biozone of Strunian age, in the dark shales with disseminated pyrite, interbedded in the massive sulphides and in the intense stockwork veins. Available palynological research of the black shales intercalated in the massive sulphides of the Caveira old mine presented similar miospore associations of the LN Biozone. Recent U-Pb geochronology data in zircons recovered from felsic volcanics ca. 300m SSE of the Caveira mine Luisa Shaft indicates an age of 361±4Ma.

At the Montinho old mine, one borehole (M1) was investigated for palynostratigraphy. Dark grey shales hosting the massive sulphides mineralisation yielded a poorly preserved assemblage assigned to LN Miospore assemblage aged late Strunian.

In the Neves Corvo mine, the massive sulphide orebodies always occur intercalated with the black shales of the Neves Formation. Detailed palynostratigraphic research in the Neves Formation, complemented with the study of samples from the black shales hosting the massive sulphide lenses (Graça, Corvo, Lombador and Semblana) including small thinly bedded (milimetric scale) black shales intercalated within the massive sulphide ore bodies allowed the determination of rich and relatively well preserved miospore assemblages assigned to the LN Biozone of late Strunian age. All the studied VMS deposits referred are intercalated in dark grey and black shales, dated late Strunian age. Considering this data and the dimension of some giant deposits (e.g. Neves Corvo and Tharsis) a significant IPB mineralization episode occurred during the time interval of the LN Biozone, and its age should be placed somewhere between 360,7 ± 0,7 Ma and 362.0 Ma (late Strunian). More research is being done, using complementary geocronological methods, in order to calibrate this interval, using the Re-Os black shale geochronometers.

The detail palynostratigraphic studies proved to be very useful to constrain the geological models and to define the more accurate exploration VMS favorable settings. Late Strunian age therefore becomes an important key stratigraphic horizon and an exploration guide in IPB, showing a favorable geological time period of ~2 Ma were the paleogeographic conditions were extremely favorable to hydrothermal fluid circulation and VMS deposits formation. These exceptional conditions were also favorable for the development of specific environmental conditions favorable to the increase of acritarchs and prasinophytes populations and to the palynomorph preservations in general. Detailed studies will be dedicated to know the paleogeographic settings of the Strunian deposition environments.

Keywords: Strunian, Palynology, Iberian Pyrite Belt, massive sulphides