Introduction: Source rocks contain measurable amounts of trace metals and rare earth elements (REEs). The trace metals present in these rocks were transferred from organic matter and sediments to porphyrin structures during the sedimentation process. The concentration of trace metals and REEs in the source rock will depend on the type and thermal maturity level of the organic matter and also on the conditions of its depositional paleoenvironment (Akinlua et al., 2016, Arning et al., 2009). Therefore, the main objective of this work was to evaluate the use of the transition elements Co, Ni, V, Mo and the rare earth elements of internal transition, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Tm, Yb, Lu and U (REEs) as indicators of the paleoenvironmental conditions of shales deposition of the Pimenteiras Formation (Devonian, Parnaíba Basin, Brazil).

Results: In this research, 11 samples of shales collected from a 15 meters high outcrop of the Pimenteiras Formation were used. The trace metals and REEs present in the shale samples were analyzed by inductively coupled plasma mass spectrometry (ICP-MS) because of their high detection capacity of parts per trillion (ppt) concentrations. The results expressed in the form of profiles showed that there were changes in the depositional paleoenvironment and the type of deposited organic matter between the samples collected from the base to the top of the outcrop (Fig. 1). Through the analysis of the diagnostic ratio profiles of saturated biomarkers Tr20/Tr21, 1/(HOP/Ster) and 1/DIA/(DIA+TPP), the characteristics of a transitional depositional paleoenvironment were observed on samples 6.1 to 6.7, followed by a marine depositional paleoenvironment on samples 6.8 to 6.11 (Zambrano, 2015) (Fig.1). These results were in agreement with results found on the study of palynofacies conducted by Andrade (2015), which reported the presence of Givetian continental organic matter at the base of the outcrop followed by an abrupt increase of palynomorphs and marine algae, such as Tasmanites and Cymatiosphaera from the Frasnian at the top of the outcrop. The Σ REEs profile showed that the elements were concentrated at the top of the outcrop, from sample 6.8 to 6.11, associated with the highest percentages of total organic carbon (% TOC) and sulfur (% ST). The ratios between the Ni/Co and V/Ni metals also suggest the terrestrial origin of organic matter (Galarraga, et al., 2008) for the samples collected in the middle and basal portions of the outcrop, while samples collected at the top of the outcrop have marine origin. The U/Mo ratio values higher than 0.15 revealed that these shales were not deposited in environments containing H2S (reducing conditions), but probably in dysoxic to suboxic conditions. The combined analysis of the U/Mo and V/V+Ni ratios (Obasi, et al., 2018) also confirmed the change in oxy-reducing conditions of the depositional paleoenvironment observed towards the top of the outcrop. Changes in the organic matter type and the paleoenvironmental conditions in which the organic matter was deposited in the Pimenteiras Formation suggest the record of a Frasnian marine flood at the top of the outcrop. The explanation for this phenomenon is not yet clear, but some authors suggest that it would be related to a mass extinction caused by a combination of factors such as fluctuations in the climate and sea level, volcanism or collision of the Earth with cosmic bodies (events of impact). These abiotic factors would have influenced oceanic biota through changes in the hydrological dynamics and the hydrothermal composition of the water, increasing the input of REEs and trace metals in the sea (Barash, 2016).
Figure 1 – Results of % TOC, % ST, Σ REEs, biomarker diagnostic ratios, Ni/Co, V/(V+Ni), U/Mo, U of 11 shale samples from Pimenteiras Formation’s outcrop (modified from Zambrano, 2015).

**Conclusions:** Transition elements and rare earth elements demonstrated the possibility of being used as indicators of changes in the input of organic matter and in the paleoenvironmental conditions of deposition of Pimenteiras Formation shales (Devonian, Parnaíba Basin, Brazil). Its application was confirmed by comparing these results with those resulting from traditionally used geochemical and palynofacies evaluations. In addition, with the contribution of the results of Σ REEs, it was possible to suggest the occurrence of a Frasnian marine flood event at the top of the outcrop.

**References**

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