MICROBIAL PRESERVATION IN SEDIMENTARY PYRITE FROM CRETACEOUS ORGANIC MATER-RICH CARBONATE MUDSTONE: A PRELIMINARY REPORT. A. Blanco1, F.J. Zavala2, J. Hernández-Ávila1, F. Maurrasse3, F. Duque-Botero4 and M. Ramírez-Cardona4. 1Centro de Investigaciones en Ciencias de la Tierra y Materiales, Universidad Autónoma del Estado de Hidalgo. Mineral de la Reforma, Hidalgo, México. Blanco.earthsciences@gmail.com. 2Departamento de Biotecnología y Bioingeniería, Centro de Investigaciones Avanzadas, Instituto Politécnico Nacional, Mexico. 3 Department Earth and Environment. Florida International University, Miami FL, USA. 4Chevron Energy Technology Company 1500 Louisiana St. Houston, TX, 77002 USA.

Introduction: The study of fossil microorganisms has experimented a real revolution during the last fifty years. Findings of fossil bacteria in sediments ranging from the Archean to the Recent, has demonstrated to be an important key for the search of life in another planets, such as Mars. Microbial fossils in pyrite have been described previously [1],[2],[3], indicating that pyrite preservation of microorganisms is not as rare as it was thought. In this study we report fossil microbes preserved in sedimentary pyrite collected from organic mater-rich mudstones of the Agua Nueva Formation (Cenomanian-Turonian/Upper Cretaceous) cropping out at Xilitla, Central Mexico [4]. The main propose of this work is to provide a general description of these fossil microorganisms in order to increase its documentation in the stratigraphic record, for further comparisons with both terrestrial and/or extraterrestrial biomorphic structures. The sedimentary pyrite analyzed here occurs as 1-2 cm thick layers within calcareous mudstone strata and is disposed as lenses parallel to the bedding.

Methods: Two samples of pyrite old rich laminated sediments were observed under Sanning Electron Microscope. Samples were broken-up into fragments of approximately 1 cc. Later, the fragments were gold coated for three minutes and analyzed. For elemental composition, the samples were analyzed by Dispersive X-ray Spectrometry (EDS).

Results: Within the pyrite laminae, both euhedral crystals and 2µm to 5µm framboinds were observed. On the same laminae, fossilized pyritized microbes were found to consists of three dimension oval to sphaerical-shaped structures, ranging from 1µm to 2µm in diameter. The morphology and sizes of the structures resembles coccoidal bacteria reported in both Recent and ancient sediments. Some of the biomorphic structures occurs as isolated elements, however, most of it occur in groups of several structures resembling bacterial colonies (Figure 1). The EDS analysis of these fossil microbes reveals the same proportion of sulfur (S) and iron as that of the framboinds and surrounding pyrite. However, the same analysis show the presence of carbon (C) in the structures (Figure 2). This result suggest an organic origin for the microscopic biomorphic structure analyzed here, which was later replaced by pyrite. Surrounding these fossil microbes, a compact and amorphous mass is present. EDS analysis on this mass shows also the presence of sulphur (S), iron (Fe) and carbon (C). Both morphology and chemical composition suggest that the pyritized mass has also an organic origin probably attributed to extracellular substances [3]. Other microbes observed in the pyrite lenses consist of rod-like structures with a length of 5µm and a width slightly less than 1µm, resembling those rod-shaped bacteria or bacillus (Figure 3).

Discussion and comment: The biomorphic structures here described expose some features such as oval to sphaerical morphologies as well as some rod-like structures within the range of size of 1µm to 5µm that allows to interpret them as remains of microorganisms. The oval and round shapes exposes similar morphology with those coccoidal bacteria reported for sedimentary pyrite from pre-Mesozoic rocks [3]. Besides, disposition of the biostructures forming groups also resembles the colonial organization of Recent bacteria. Presence of iron (Fe) and sulphur (S) in the biostructures indicates pyrite is present. This mineral is found replacing the cellular walls of the bioforms during the early diagenesis [3]. The presence of carbon (C) in the microbes suggest their organic origin. It is known that some results that reveal carbon (C) in sediments like chert or even pyrite could be relict of calcium carbonate (CaCO₃) minerals [5]. However, comparative analysis between the pyrite matrix and fossils microorganisms reveal that the content of carbon (C) is considerably lower in the matrix. High content of carbon is only present within the bioforms, suggesting a biotic origin.

So far, is well known that several authors have emphasized the importance of the finding of fossil microorganisms in the sedimentary record for the search of extraterrestrial life [3], [6]. On the other hand, the discovery of microscopic bioforms in Martian meteorites [6], [7], has increased the debate about the existence of microscopic life in this planet. Recent reports suggesting the possibility of the presence of pyrite in Martian
sediments [8], [9], (e.g. Mudrocks), let the possibility to associate biotic activity to the genesis of this mineral, as occur in Earth.