Calcium carbonates detected in Martian meteorites may be indicative of the existence of paleolakes on Mars.

B. L. Nascimento-Dias[1]; V. C. dos Anjos[1], M. E. Zucolotto[2], Department of Physics, Federal University of Juiz de Fora, PPGF, Brazil[1] and National Museum of Rio de Janeiro[2] (bruno.astrobio@gmail.com)

Introduction:
In some Martian meteorites, such as NWA 6963 and ALH84001 was detected CaCO3 (mineral of carbonate). In general, this kind of mineral is formed in aqueous environment. Another point is the carbonates are excellent geomarkers and can maintain records of biosignatures preserved in their materials on Mars. Sedimentary deposits in environments of primitive lakes on Mars, could be a good place with those fossil impressions and records still preserved [1].

Methodology: The Raman spectra was obtained by Confocal SENTERRA BRUKER at Federal University of Juiz de Fora (UFJF). The Instrument is equipped with a thermoelectrically cooled CCD (ANDOR DU420-OE) with a spectral resolution of ~ 4 cm^{-1} in the 100–4000 cm^{-1} range and a continuous automatic calibration (0,1 cm^{-1} theoretical accuracy). The analyses were performed using a 50X objective lens on the Raman microscope and was used a 632.8 nm laser standardized with at 5 mW for excitation. Calibration was made on silicon (521 cm^{-1}). The acquisition of the XRF spectrum was done in a vacuum of 20 mbar from parameters adjusted so that the measurements were taken in a standardized way. The parameters used were the current in 600 µA, voltage of 40 kV and in two cycles with a total duration of 2h 10min.

Results Using raman was detected a strong ν1 Raman shift between 1080–1090 cm^{-1} in Martian meteorite NWA 6963 an ALH84001 (Fig.1 and Fig.2). This peak is called "internal modes" due they originate from vibrations between the C and O of carbonate (CO3) and suggest the presence, per example, of Calcite (CaCO3) [2-3]. Furthermore, other important results were collected using XRF in Martian meteorites. µXRF provided important information regarding the location of certain chemical elements, such as P, Ca and Y, and these elements may be forming 1, 2 or even 3 different biominerals, such as Calcite (CaCO3), Apatite [$Ca_5(PO4)_3(OH,F,Cl)$] and Merrillite [$Ca_9NaMg(PO4)_7$] [4].

Discussion:
Though yet not detected life on the surface of Mars at the present, this does not exclude the possibility that life may have thrived on the primitive environment of the Red Planet. In addition, calcium carbonates, such as those detected in the NWA 6963 and ALH84001 meteorites, may come from sedimentary deposit environments (Fig.3). Thus, these minerals are important geomarkers of primitive aqueous regions (for example, paleolakes) and can preserve the biosignatures of that time. In fact, also is important to remember, microbialites are rock or benthic sedimentary deposits made of carbonates (Fig.4).
Then, carbonates could be seen as a kind of "biosignature" or connected with some signal of primitive life [5]

Conclusions: The early history of Mars seemed to have a hydrosphere very similar to that of Earth. Apparently, on Mars had sedimentary deposits and these places are good indicative of aqueous origin, such as paleolakes. The carbonates found in both Martian meteorites can be seen as good indicators of this primitive Mars scenario. ALH84001 is an ancient meteorite and considered historically as a fragment from the Nochian eon, on another hand NWA 6963 is considered to be a fragment of recent Mars history. Thus, based on results, the Martian hydrosphere may have existed in the early days of Mars, and the last glacial-fluvial episodes appear to have occurred during the Upper Hesperian eon or later. In conclusion, information like this can serve as reference guides for future missions, such as perseverance, in addition to contributing more to studies of Martian meteorite mineralogy

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Reference [1] Ellery, A., et. al (2004). JRS, 35(6), 441-457. [2] De La Pierre, M. et al. (2014). JCP, 140(16), 164509.[3] Steele, A. et al. (2007). *Meteoritics & Planetary Science*, 42(9), 1549-1566. [4] Nascimento-Dias, B. L., (2018). IJA, 1-6. [5] Noffke, N. (2015). *Astrobiology*, *15*(2), 169-192.

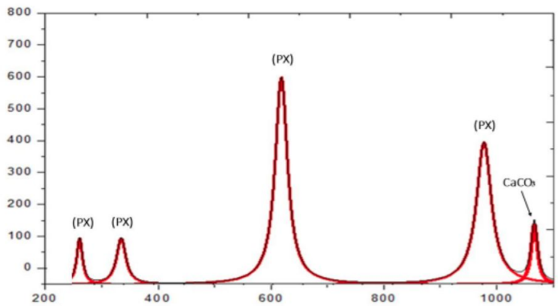

Figure 1- NWA 6963 Raman Spectrum and Calcium Carbonate Detection. Legend: PX is Pyroxene and $CaCO_3$ is a Carbonates

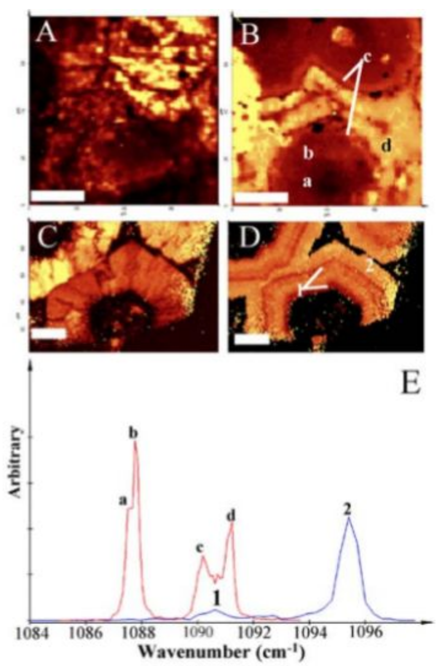

Figure 2- ALH84001 Raman Spectrum and Calcium Carbonate Detection by Steele et al (2007)

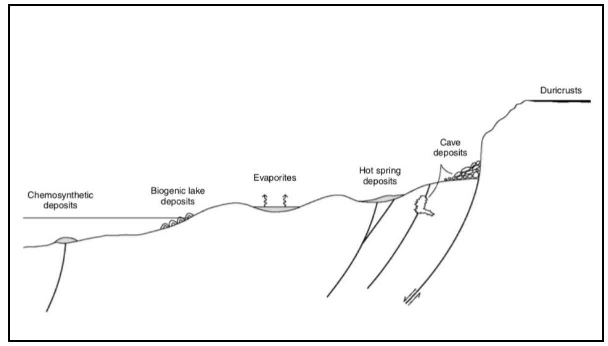

Figure 3 - Range of surface environments as possible astrobiological targets by Ellery et. al (2004)

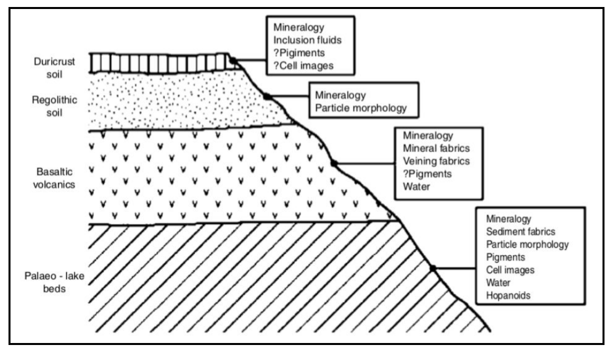

Figure 4 - Hypothetical cross-section through Martian depositional strata by Ellery et. al (2004)