

# Volcanic deposits from Mount Etna (Italy) as high-fidelity lunar simulants for In-Situ Resource Utilization (ISRU) applications

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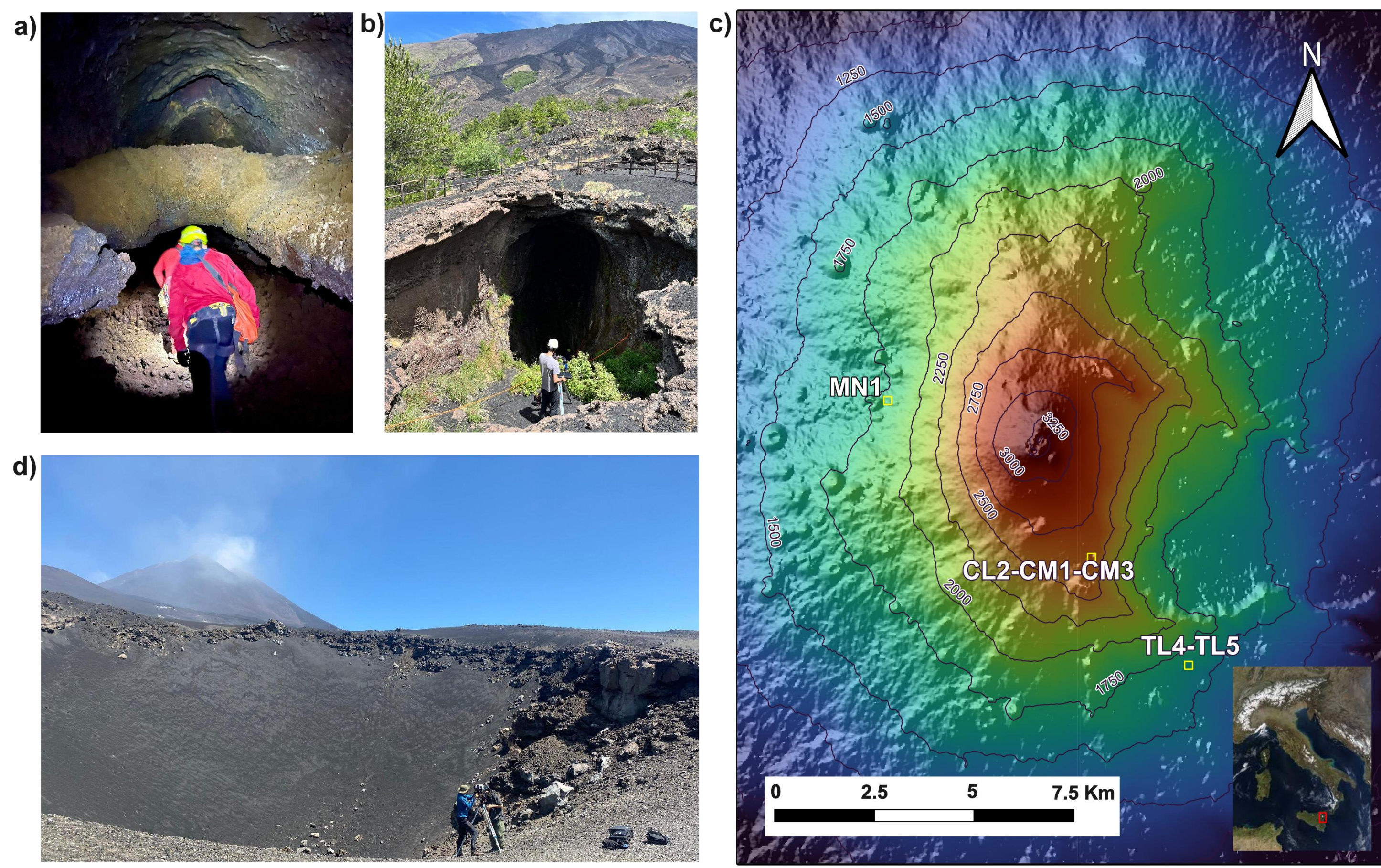
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## Background

Mount Etna is an important planetary analogue either for composition and for its geological diversity which includes lava tubes, cinder cones and pyroclastic deposits. It has already garnered interest from the planetary science community and shares several geological features with the Moon, but its compositional similarity—particularly regarding pyroclastic deposits—has yet to be fully established.

## Sampling Campaign

Several samples were collected from: a) Tre Livelli Cave, b) Monte Nunziata Cave and d) a pyroclastic deposit in the Cisternazza pit crater.

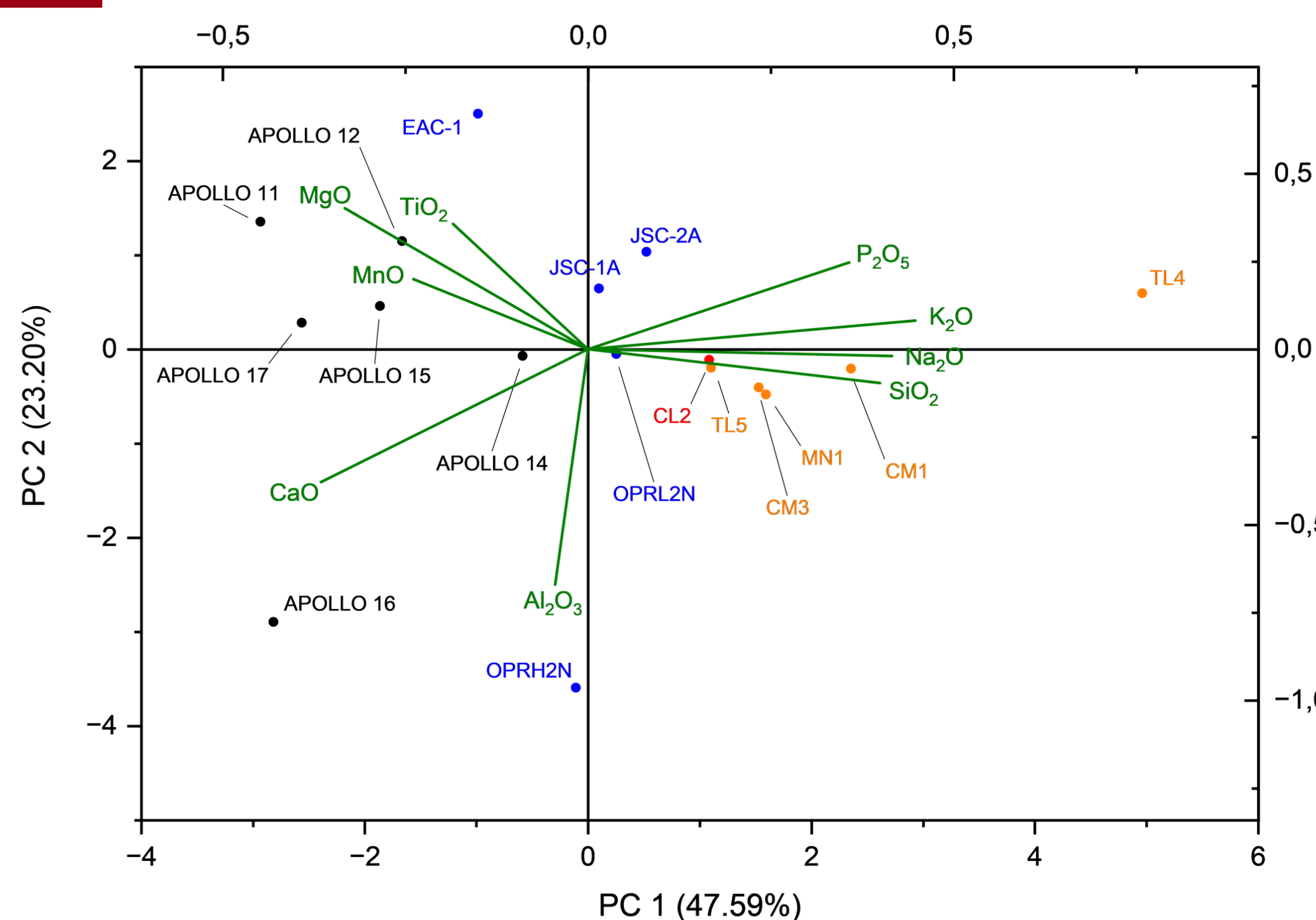


## Materials and Methods



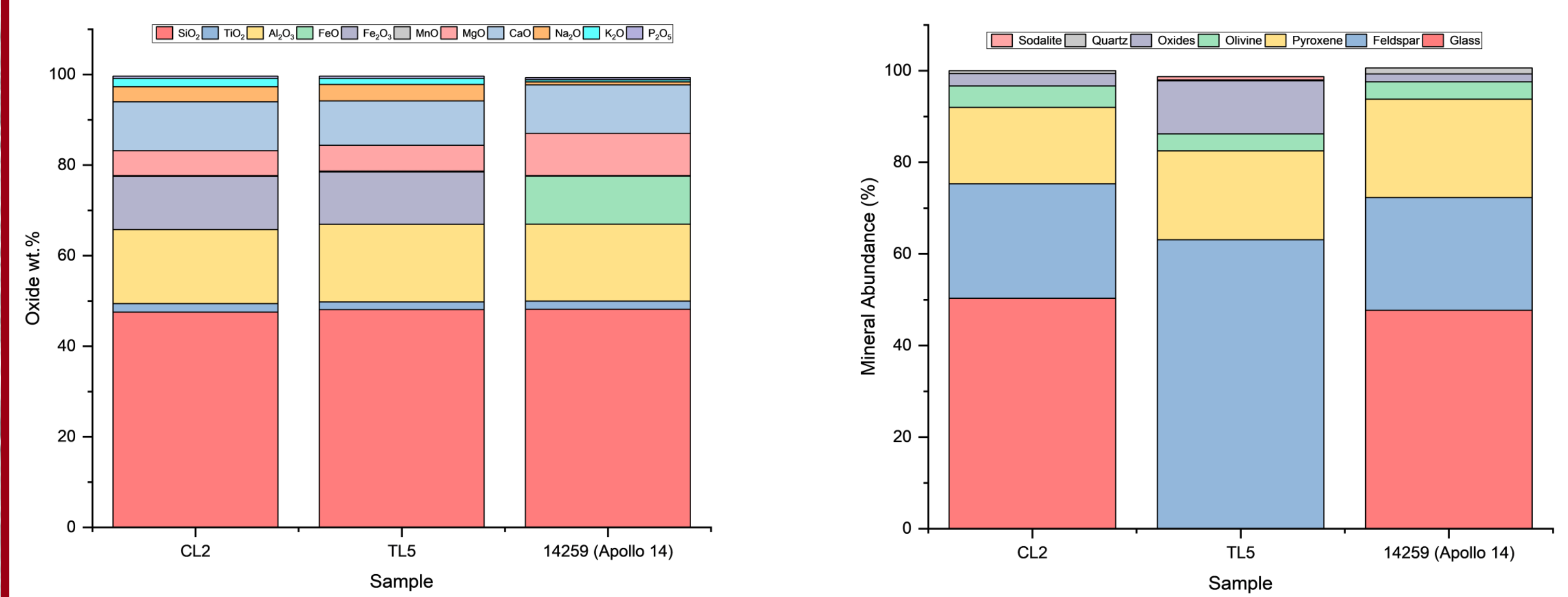
An initial chemical screening was conducted using the XRD and XRF techniques to trace similarities with lunar samples. We did detail analysis including hyperspectral acquisition, SEM and ICP-OES. The sieving of this pyroclastic material has been standardized according to ASTM standards to align the Particle Size Distribution (PSD) with that of Apollo samples.

## PCA Results



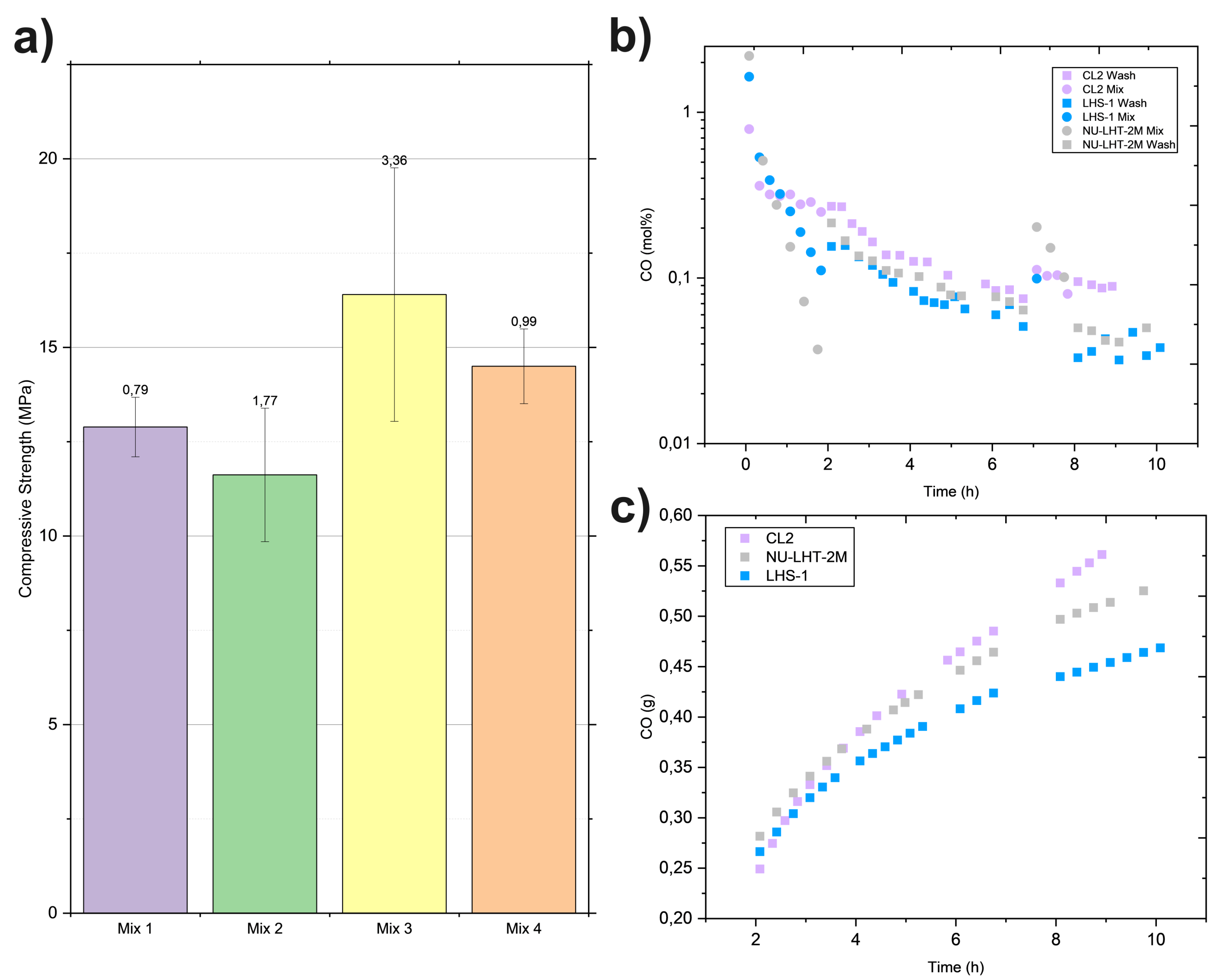
To assess potential similarities between Etna's samples and the Apollo samples, Principal Component Analysis (PCA) was conducted; CL2 and TL5 exhibits chemical similarities to the average composition of Apollo 14 samples

## XRD-XRF Results



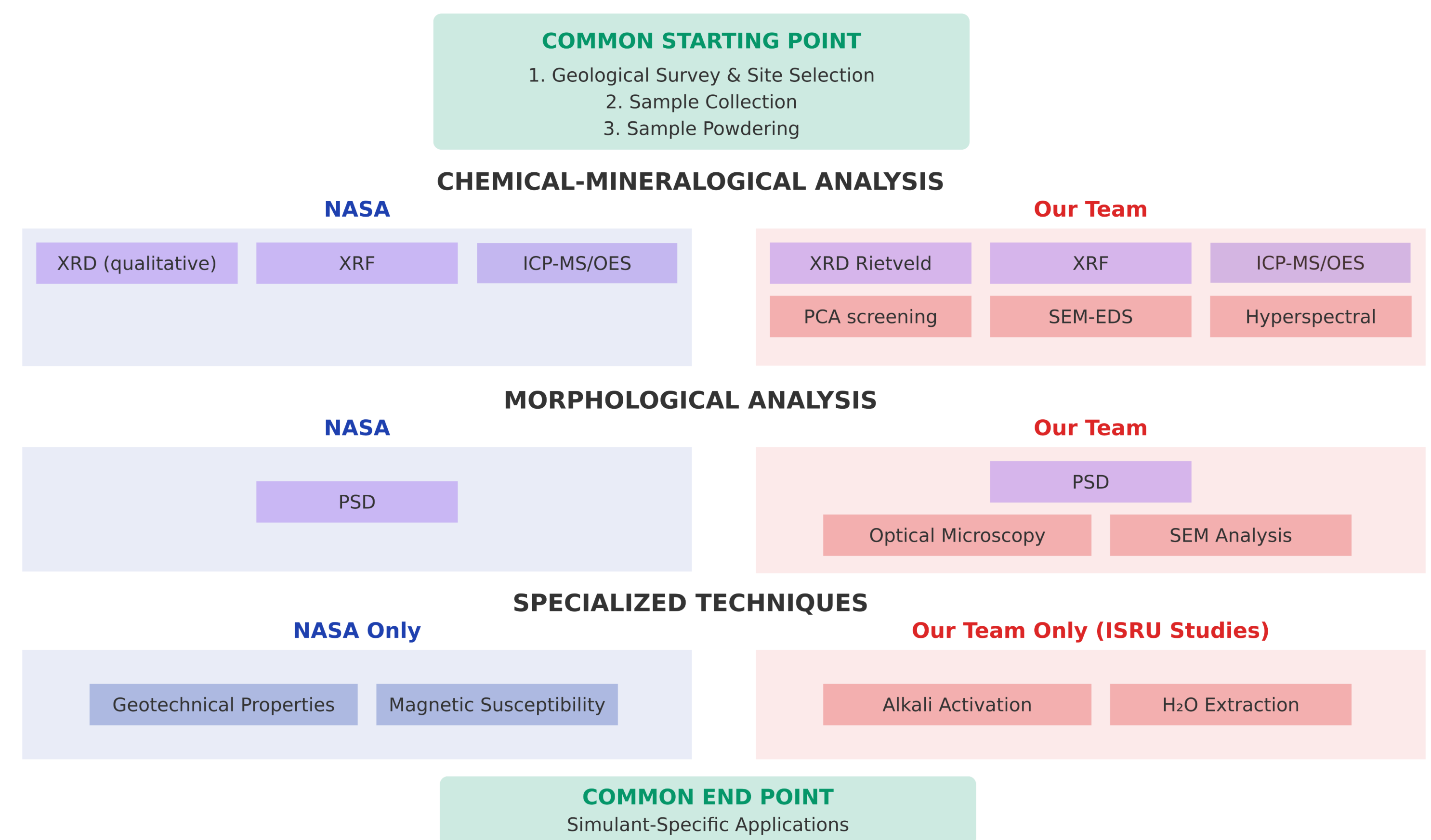
Chemical (XRF) and mineralogical (XRD) comparison between CL2, TL5 and 14259 (Apollo 14) sample. To estimate the percentage of amorphous content in XRD analysis, the samples were prepared with an internal standard (10% ZnO).

## ISRU Applications



a) Compressive strength tests performed on alkali-activated specimens after 28 days curing at 25 °C and 65 % RH. b) Results in terms of molar percentage of CO (log10) in the flow downstream of the carbothermal reactor, retrieved from chromatograms. c) The integrated CO mass extracted during the carbothermal process, calculated from gas chromatograph data.

## Comparative analytical workflows



Comparative analytical workflows for regolith simulant characterization. Both NASA (blue pathway) and our team (red pathway) begin with geological survey and sample preparation, then diverge into specialized analytical approaches before converging on simulant applications.