

Regolith Evolved Gas Analyzer (REGA)



**An Instrument to Study
Martian Soil Mineralogy and Atmospheric Composition**

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Regolith Evolved Gas Analyzer (REGA)



What is REGA?

- **REGA is an instrument designed for operation on the surface of Mars to:**
 - **Measure and determine the mineralogical composition of soil samples.**
 - **Measure and determine the reactivity of soils.**
- **REGA identifies and quantifies by mass spectroscopic analysis the gases and vapors released from programmed heating of soils.**
- **REGA provides long term monitoring of atmospheric composition.**

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REGA Science

- Expected results from operation on surface of Mars:
 - **Mineralogical composition of soils.**
 - **Chemical reactivity of soils.**
 - **Composition of Atmosphere.**
- Lead to:
 - **Understanding of geological and climatological histories of Mars.**
 - **Identifying prerequisite components for existence of life.**
 - **Specifically finding existence of carbonates and evaporites- these contain water, the prerequisite for life.**
 - **Assessing possible environmental hazards to be encountered by future human explorers and their equipment.**

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REGA Instrument Operation

An external scoop or drill deposits soil samples into the instrument sample hopper.

Sample hopper contains sieve that separates particles of < 500 μm size and meters them into a fresh stainless steel crucible.

Sample size 0.1 to 0.3 cc.

Mechanical arm moves crucible to furnace, inserts it in furnace, closes furnace.

Sample is heated to 900 °C in stepwise manner.

Gases evolved from soil are transferred to mass spectrometer for analysis.

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REGA Soil Handling System

■ Description

Consists of sample hopper with soil sifter and volume metering mechanism.

Storage rack for 30 stainless steel crucibles .

Three stepper motors to:

- drive mechanical arm to move crucibles from soil handling system to furnace and used crucible from furnace.**
- open and close furnace.**
- operate soil sifter and metering.**
- dump excess bulk soil in hopper out side chute.**

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REGA High Temperature Furnace

- | Cylindrical furnace heats soil sample and crucible from ambient temperature to 900°C following programmable temperature profile.**
- | Efficient insulation minimizes heater power - only 26 watts required to reach 900 °C.**
- | Metal-to-metal seal between upper and lower furnace sections seals in evolved gases.**
- | Heated transfer tube moves controlled amounts of gasses to mass spectrometer for analysis.**
- | Valved exhaust tube vents evolved gases to ambient atmosphere to control pressure in furnace.**

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REGA Mass Spectrometer

■ Description

- Double-focusing magnetic sector-field analyzer**
- Ceramic electron multiplier detectors**
- Weight of analyzer- 900 gms**
- Performance parameters**
 - | Mass range: 2 - 200 2 channel**
 - | Mass resolution: $m/\Delta m = 200$**
 - | Dynamic range: 5×10^6**
 - | Sensitivity: 5 ppb (using isotopic peaks)**
 - | Spectral scan: Adjustable with microprocessor**
 - | Output signal: Digital - Counting rate for each mass peak in spectrum**

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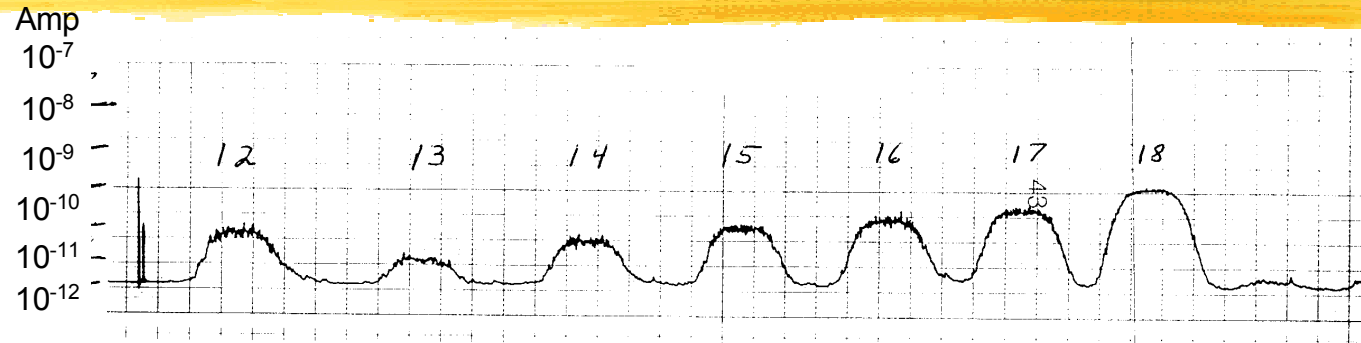
REGA Mass Spectrometer

■ Operation

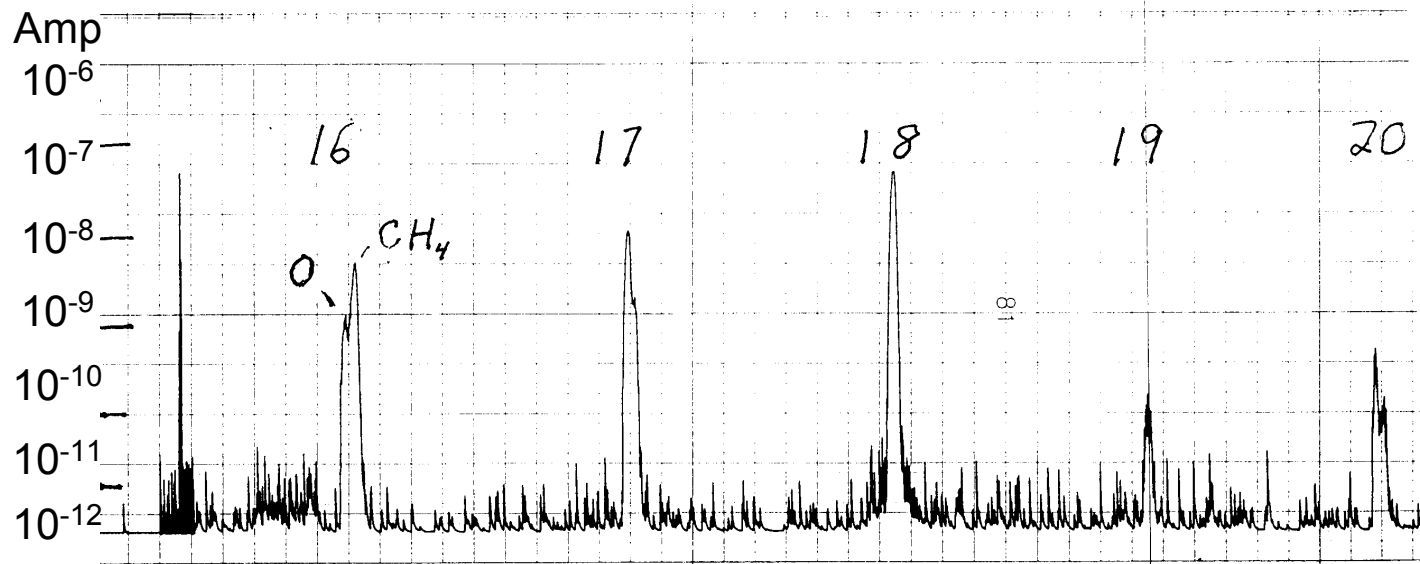
- Gases evolved from heated samples in furnace transferred to mass spectrometer ion source through a heated tube containing a constriction acting as a leak.**
- Ion source region separated from mass analyzer via object slit of ion optics.**
- Pressure in source region maintained at 1×10^{-5} torr.**
- Analyzer section pumped by getter and miniature ion pump. Pressure at 10^{-8} torr**
- Ion source:**
 - 4 electron beam energies from 90 to 20 eV.**
 - 2 emission currents: 250 and 25 microamps.**

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Low mass



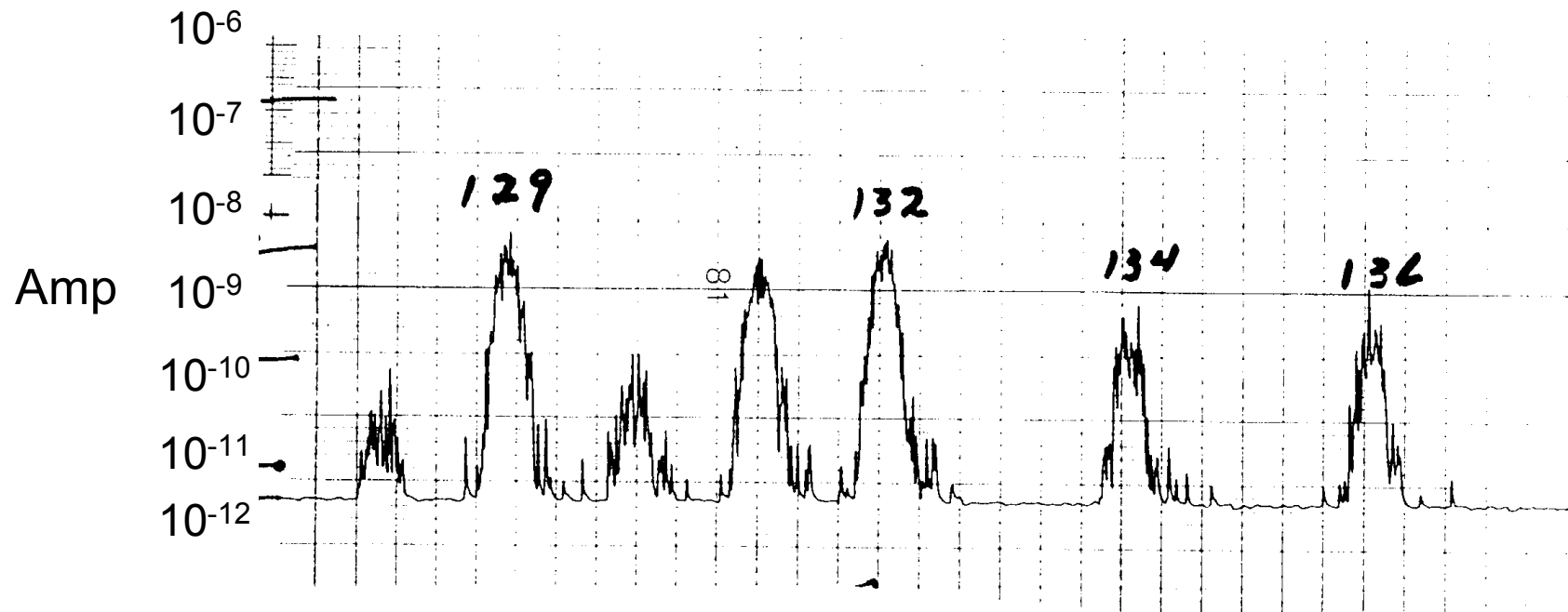
High mass



Mass spectra on low and high mass channels

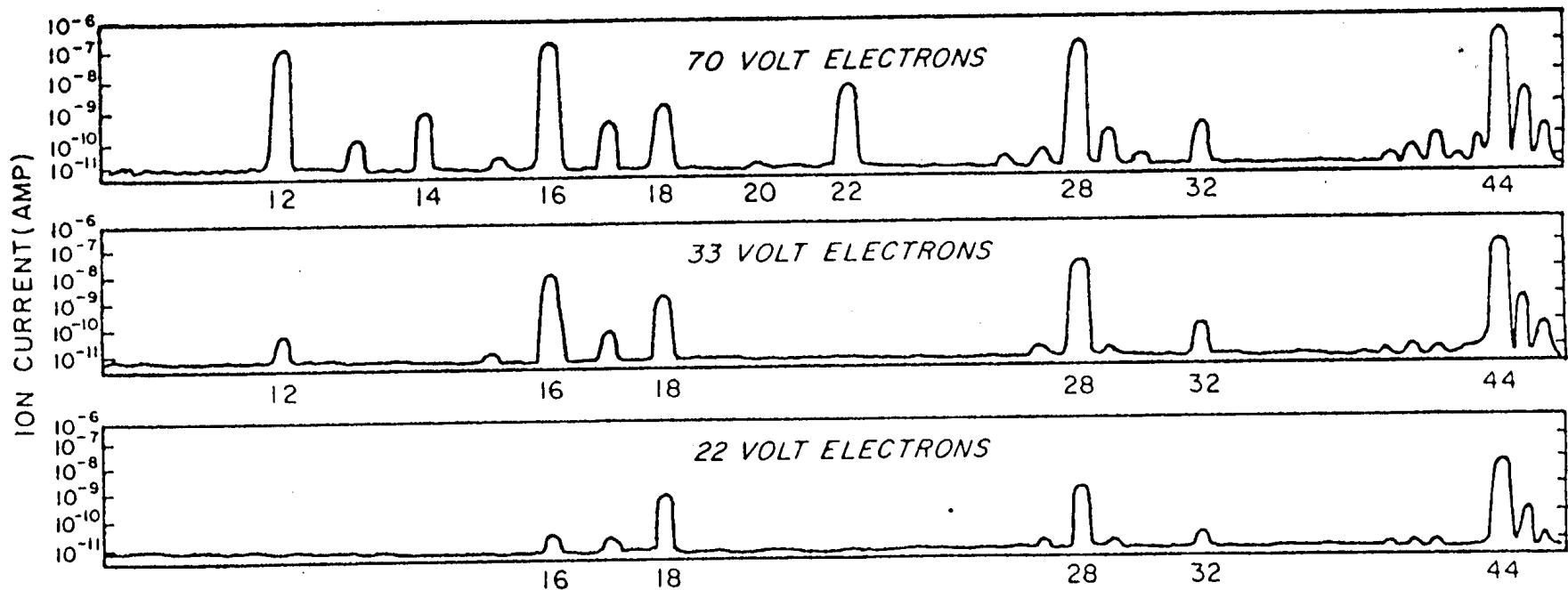
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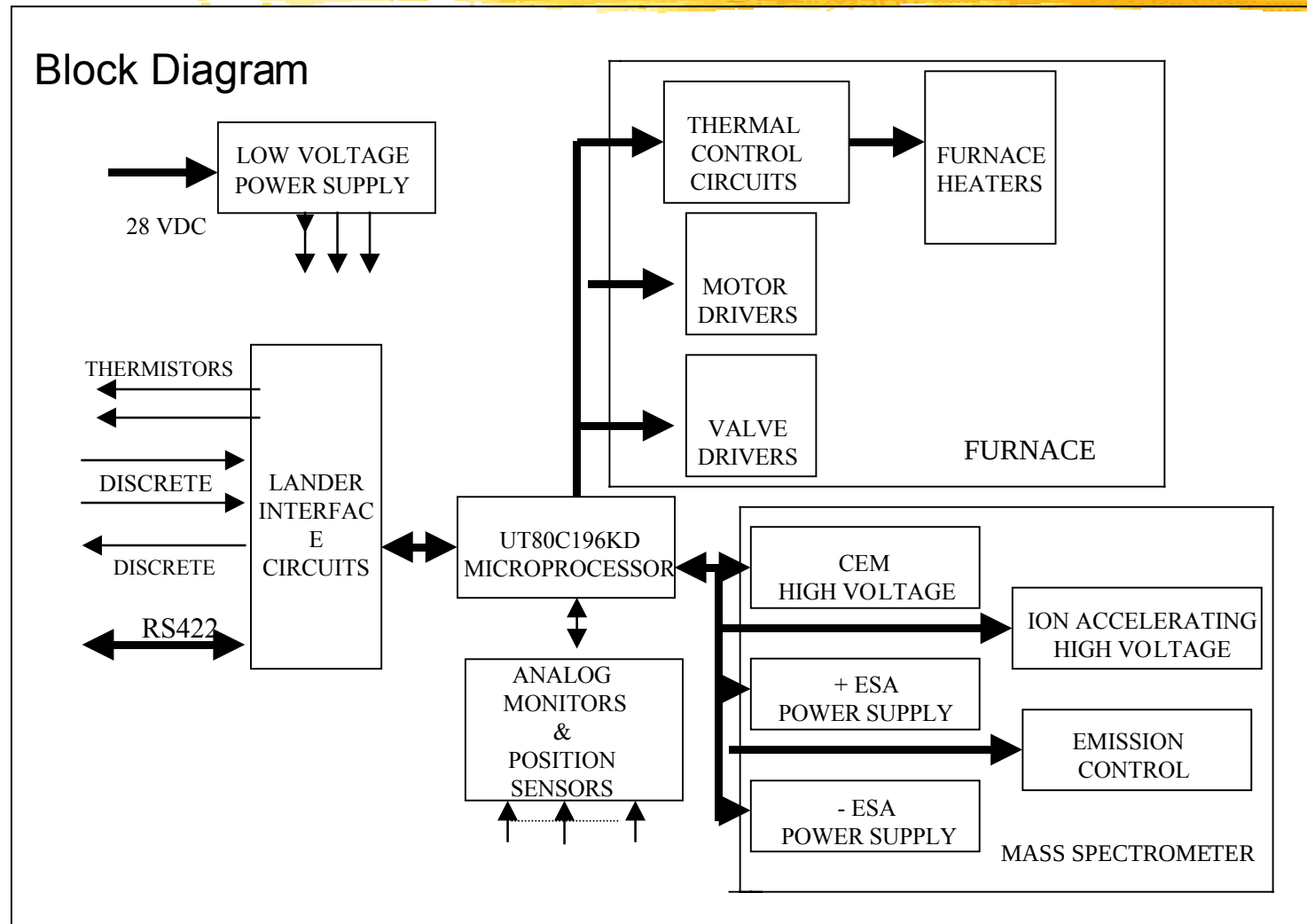
Xenon mass spectrum

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CO₂ spectra at several electron energy levels

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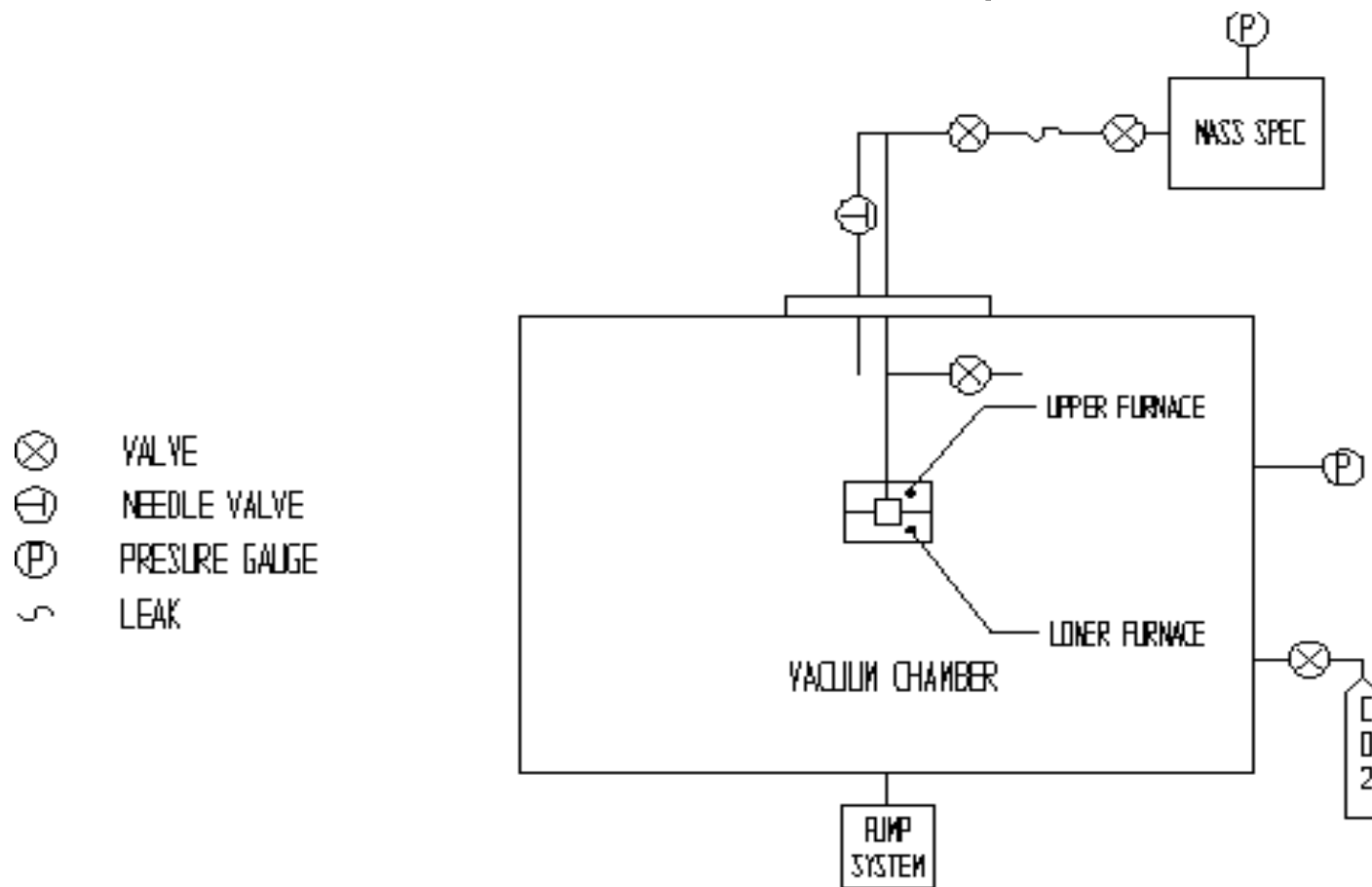
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REGA Test Set-up

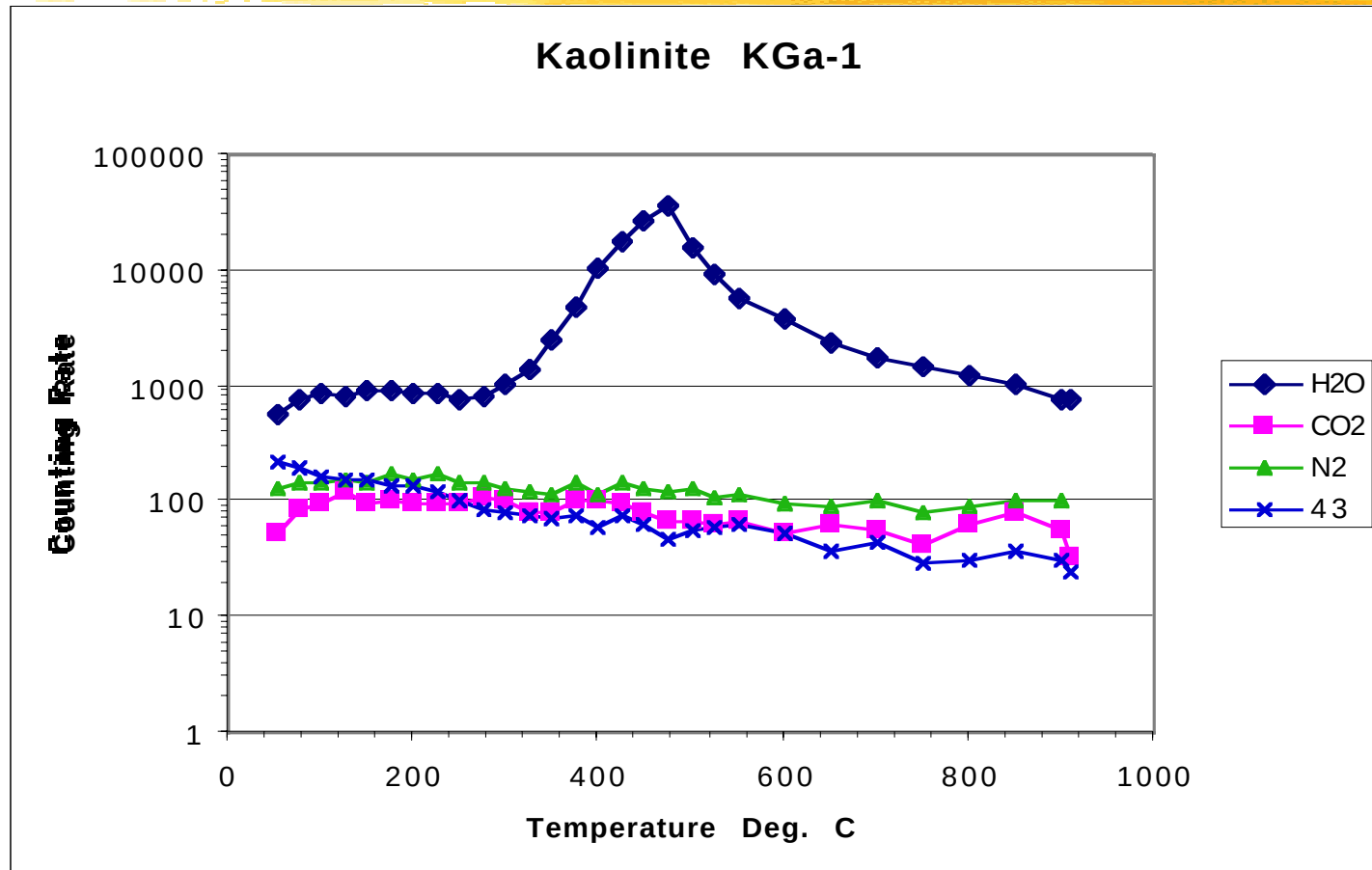


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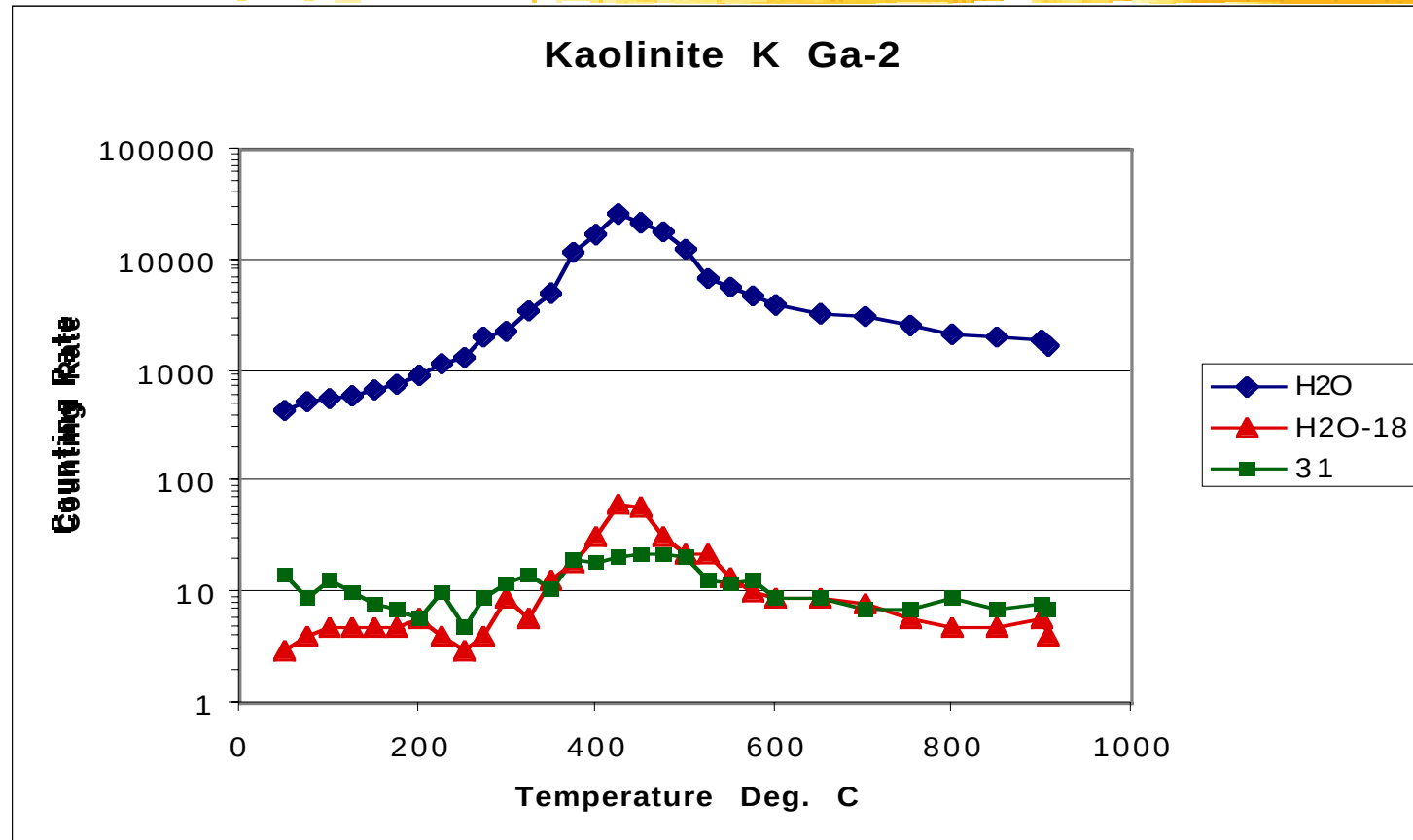


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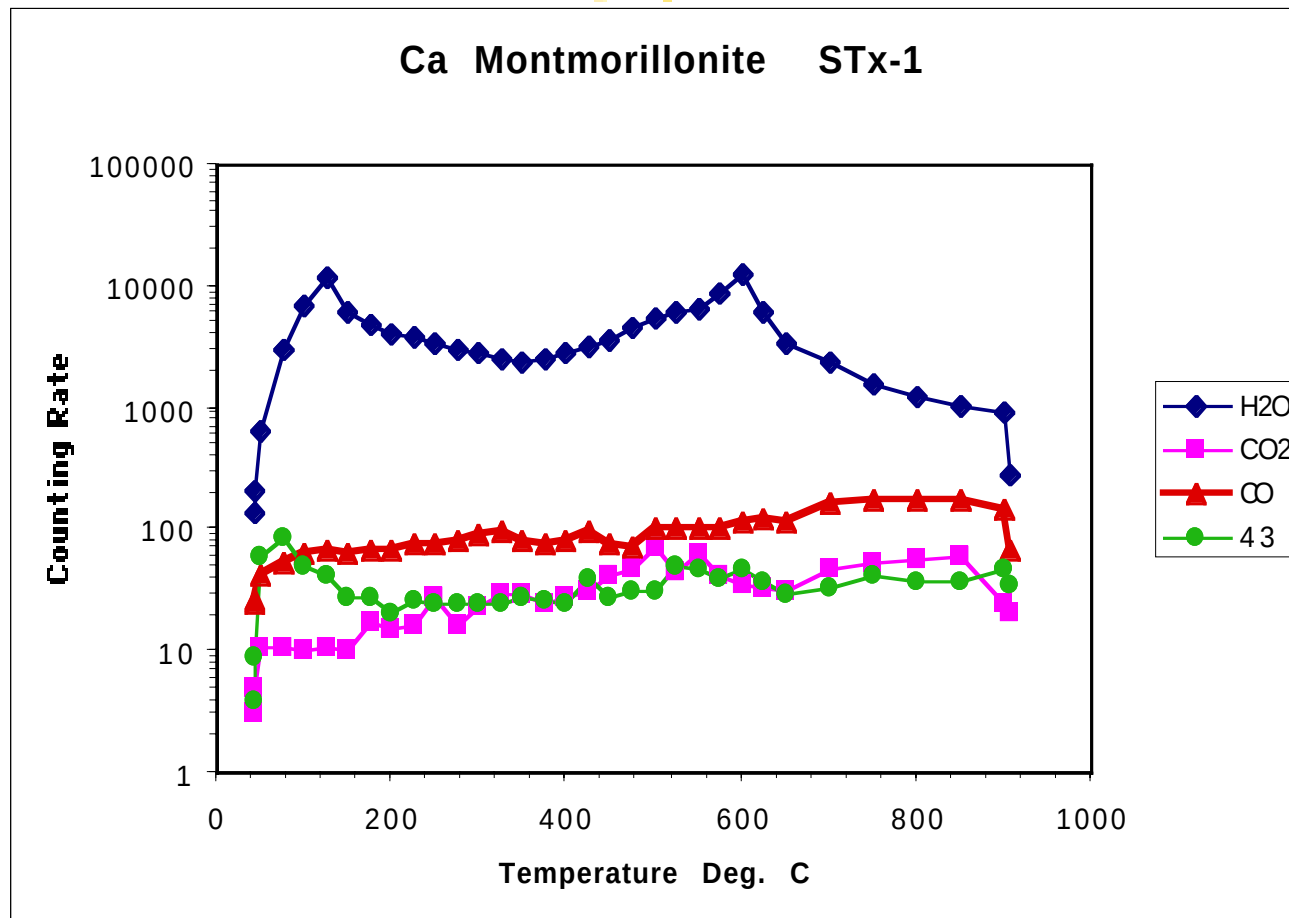
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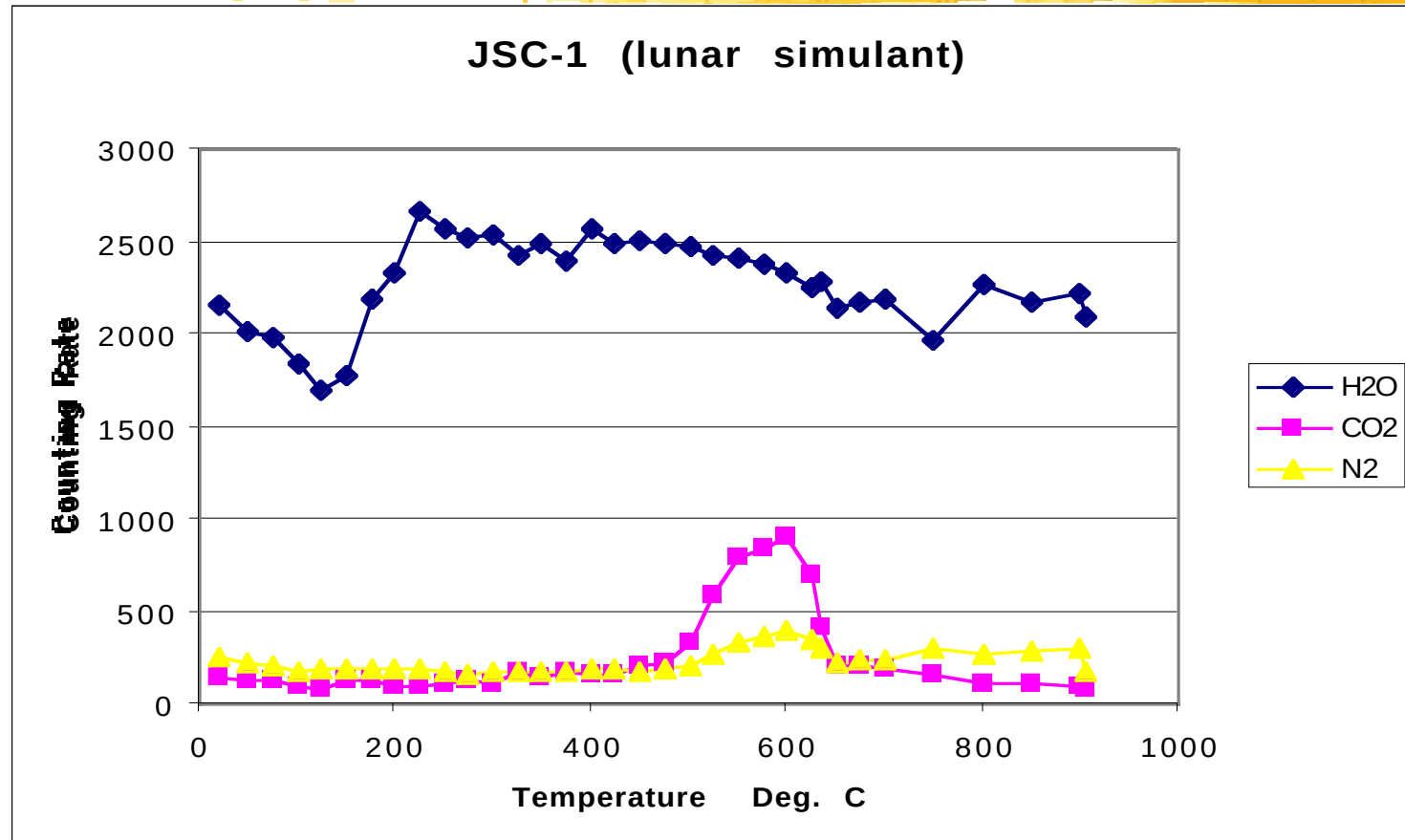
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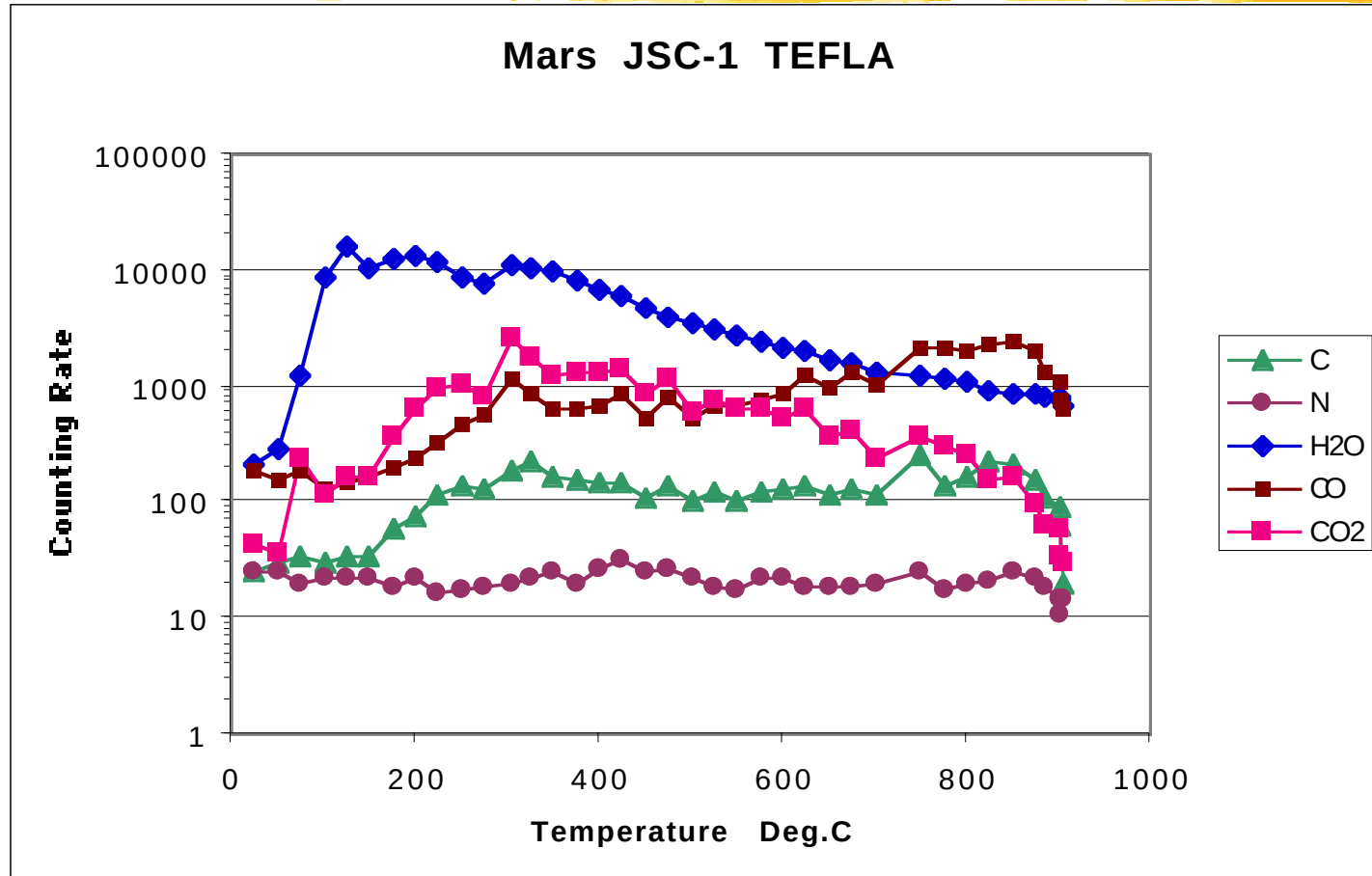
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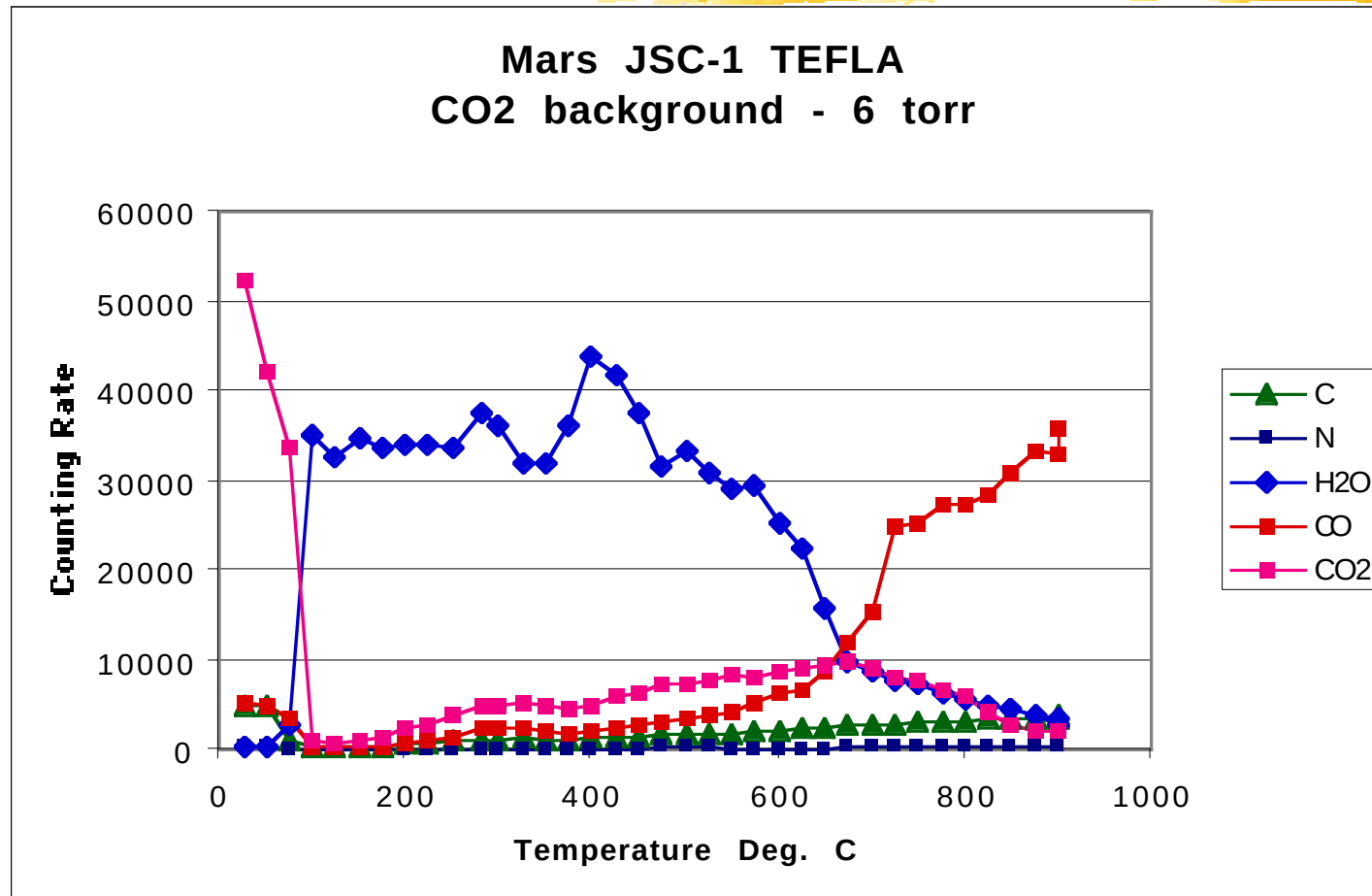
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Conclusion

- Demonstration:
 - REGA instrument's capability to extract and measure volatile materials from simulated martian soils.

- Development stage:
 - Software for operation of furnace system and mass spectrometer.
 - Instrument model for further tests with soil simulants.