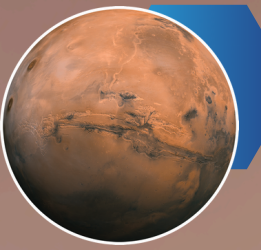


BIOSIGNATURE PRESERVATION IN ACIDIC AND CIRCUMNEUTRAL ICELANDIC HOT SPRING DEPOSITS

PHYLINDIA GANT & AMY WILLIAMS
UNIVERSITY OF FLORIDA

Lunar and Planetary Science Conference 2025



MARS HABITABILITY

BIOLOGICAL INTEREST



Warmer environment

Presence of liquid water

Prebiotic molecules

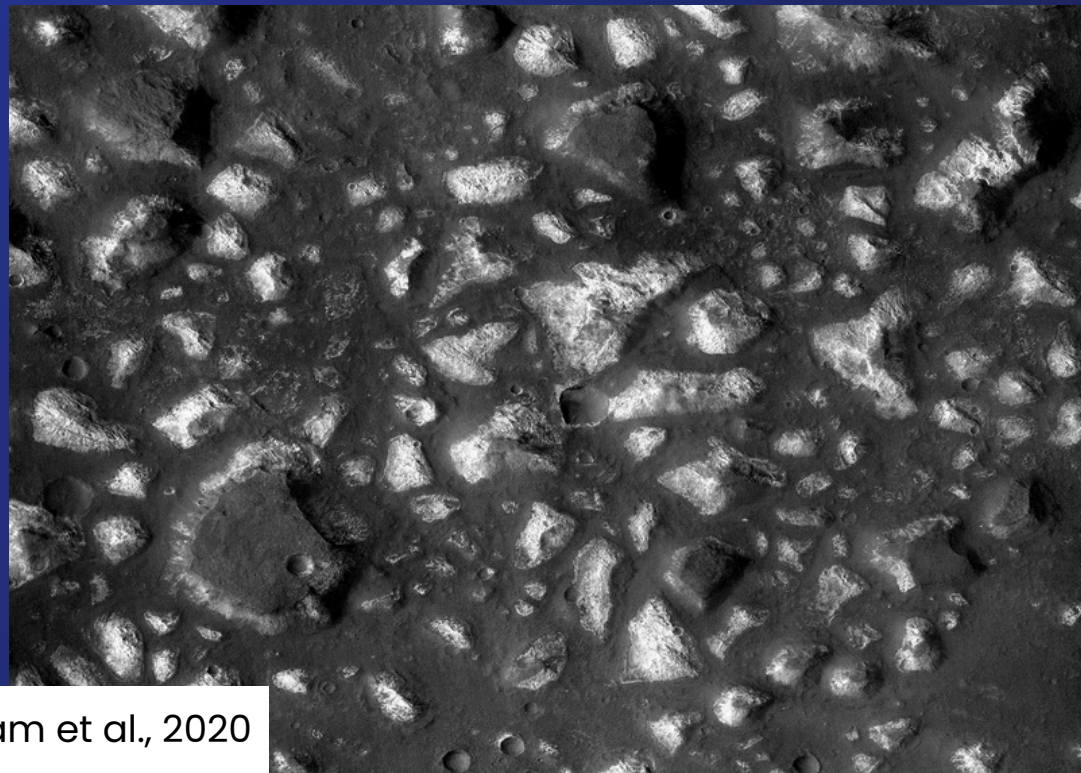
Energy sources for metabolism

Mars / Iceland

Iceland is a compelling Martian analog



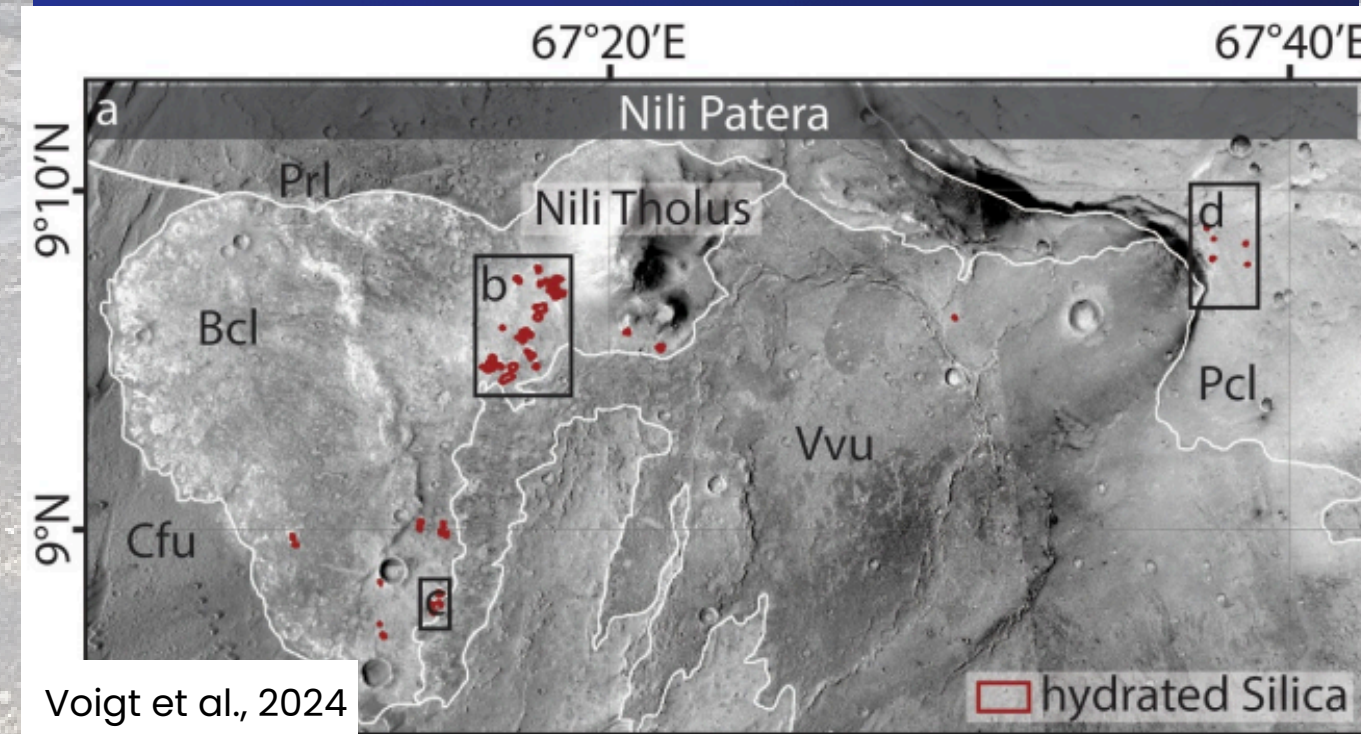
Hydrothermal Activity



Sam et al., 2020



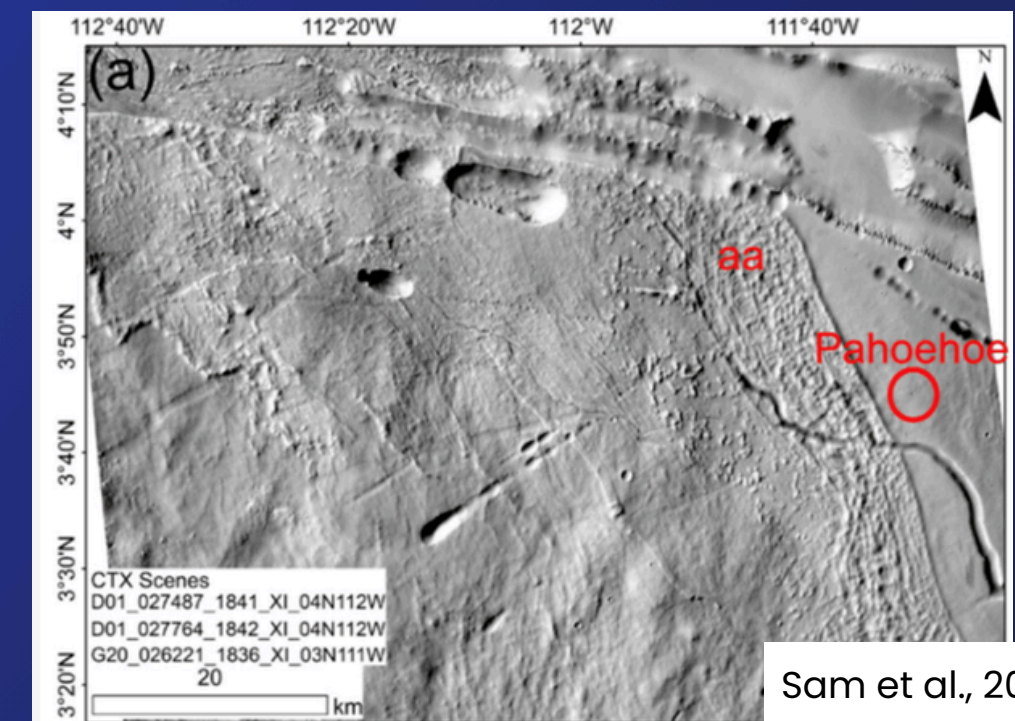
Hydrated Minerals



Voigt et al., 2024



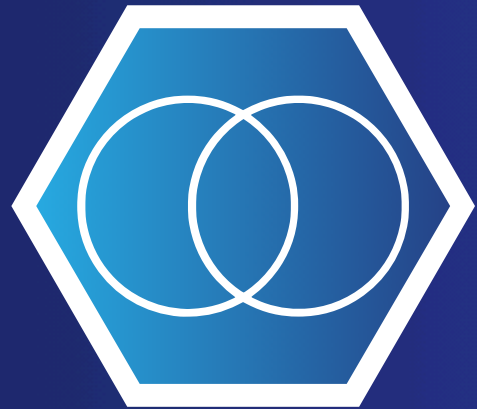
Basalt Volcanic Materials



Sam et al., 2020

Biosignature Investigation

First study directly comparing acidic to circumneutral Icelandic Hot spring deposits, their preservation potential, and their detectability with modern space flight – like technology



Compare

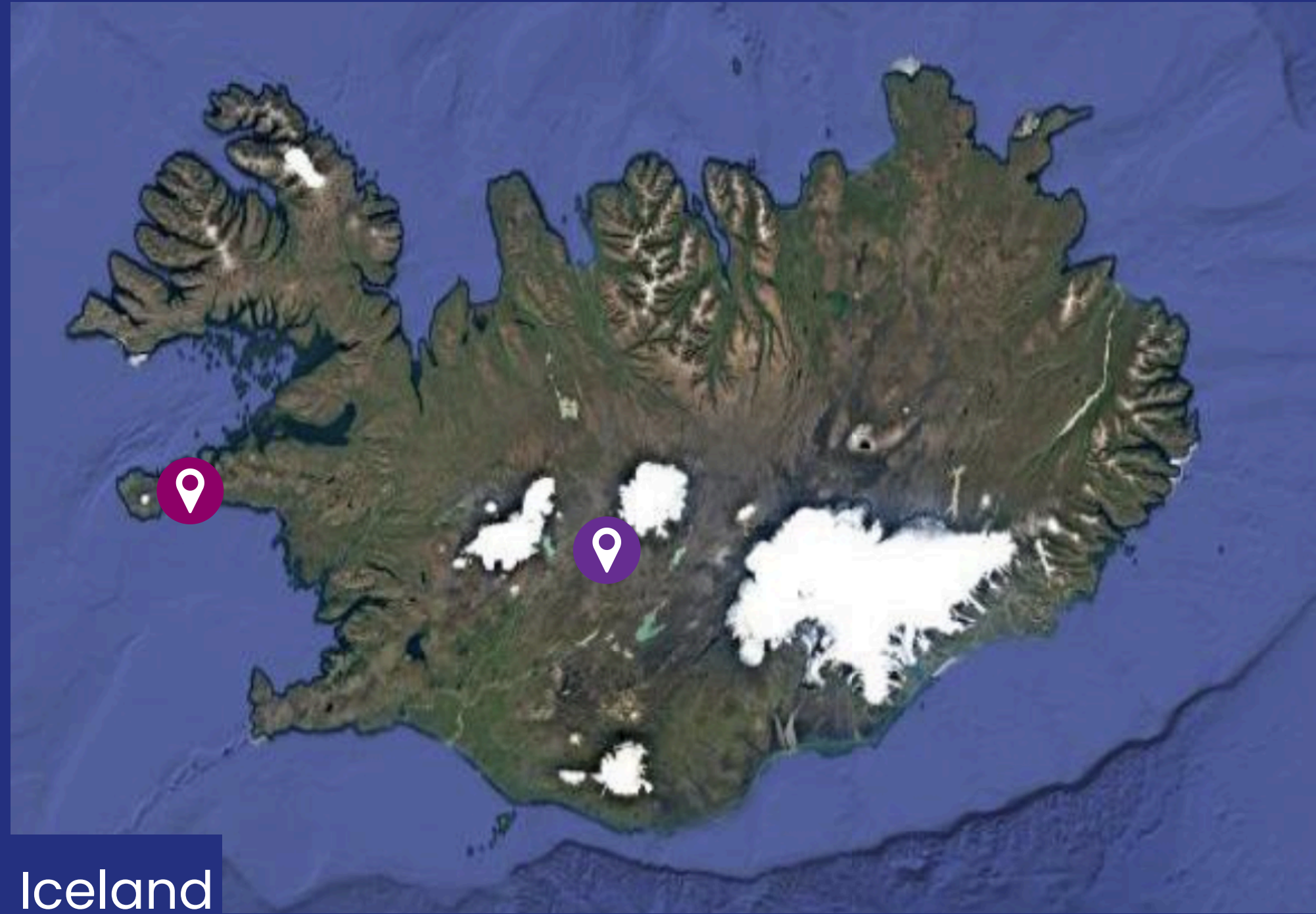


Preserve



Detect

Iceland sample Location



Acidic Iron Spring



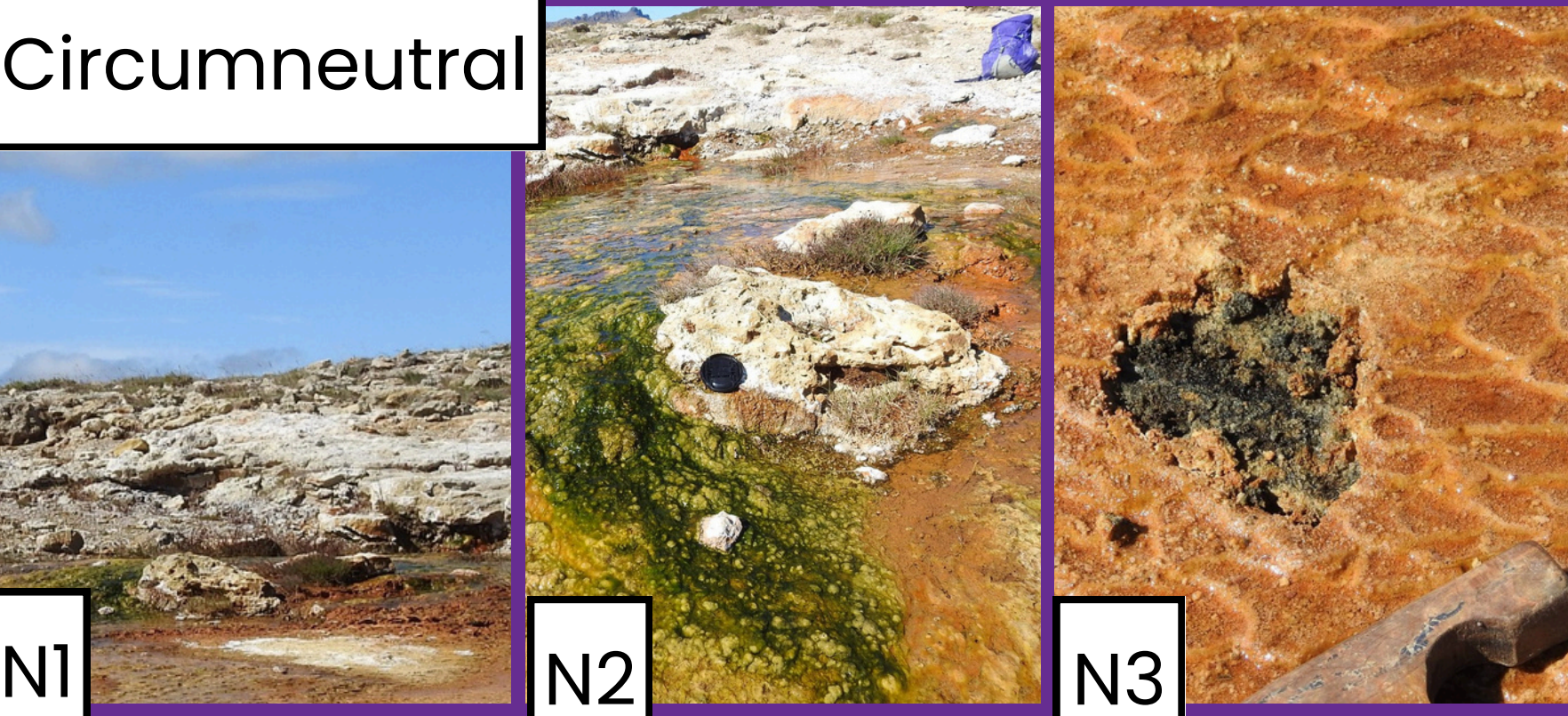
Neutral Iron Spring

Iceland sample Location

Acidic



Circumneutral



ID	A1	A2	A3	A4	A5`	A6	A7
TC (%)	0.18	0.09	0.24	0.1	0.3	0.12	0.14
Mineralogy	Poorly crystalline iron oxide	Poorly crystalline iron oxide	Hydrated iron sulfate Quartz	Goethite Quartz	Goethite	Goethite Quartz	Goethite Quartz

N1	N2	N3
0.41	0.58	0.58
Calcite	Opal-A	Amorphous



Pyrolysis

Heat used to break down large molecules into smaller molecules



Derivatization

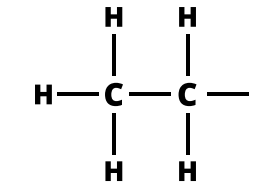
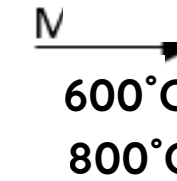
Use of a reagent to make organic molecules more polar and detectable by GC-MS

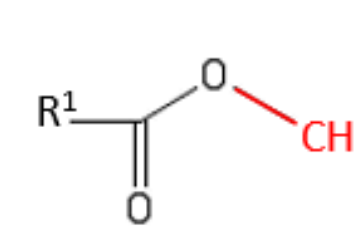
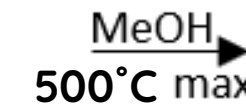


Thermochemolysis

Degradation of organic compounds through heating in the presence of a chemical reagent



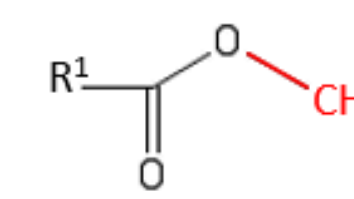
R/C=C\CCCCC
$$+ \text{H}-\text{C}=\text{C}-\text{H}$$

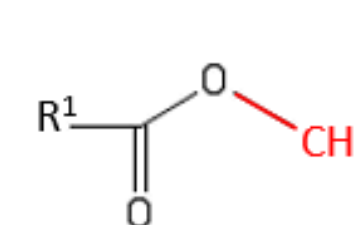
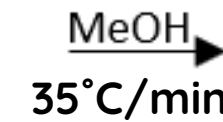
$$\text{R}^1-\text{C}(=\text{O})-\text{O}\cdot\text{H}$$
$$+ \begin{array}{c} \text{CH}_3 \quad \text{OH} \\ | \\ \text{H}_3\text{C}-\text{N}^+-\text{CH}_3 \\ | \\ \text{CH}_3 \\ \text{TMAH} \end{array}$$

$$+ \begin{array}{c} \text{CH}_3 \\ | \\ \text{H}_3\text{C}-\text{N}-\text{CH}_3 \end{array}$$
$$+ \text{H}-\text{O}-\text{H}$$
R1C(=O)O

+



TMSH


$$+ \text{H}_3\text{C}-\text{S}-\text{CH}_3$$
$$+ \text{H}-\text{O}-\text{H}$$

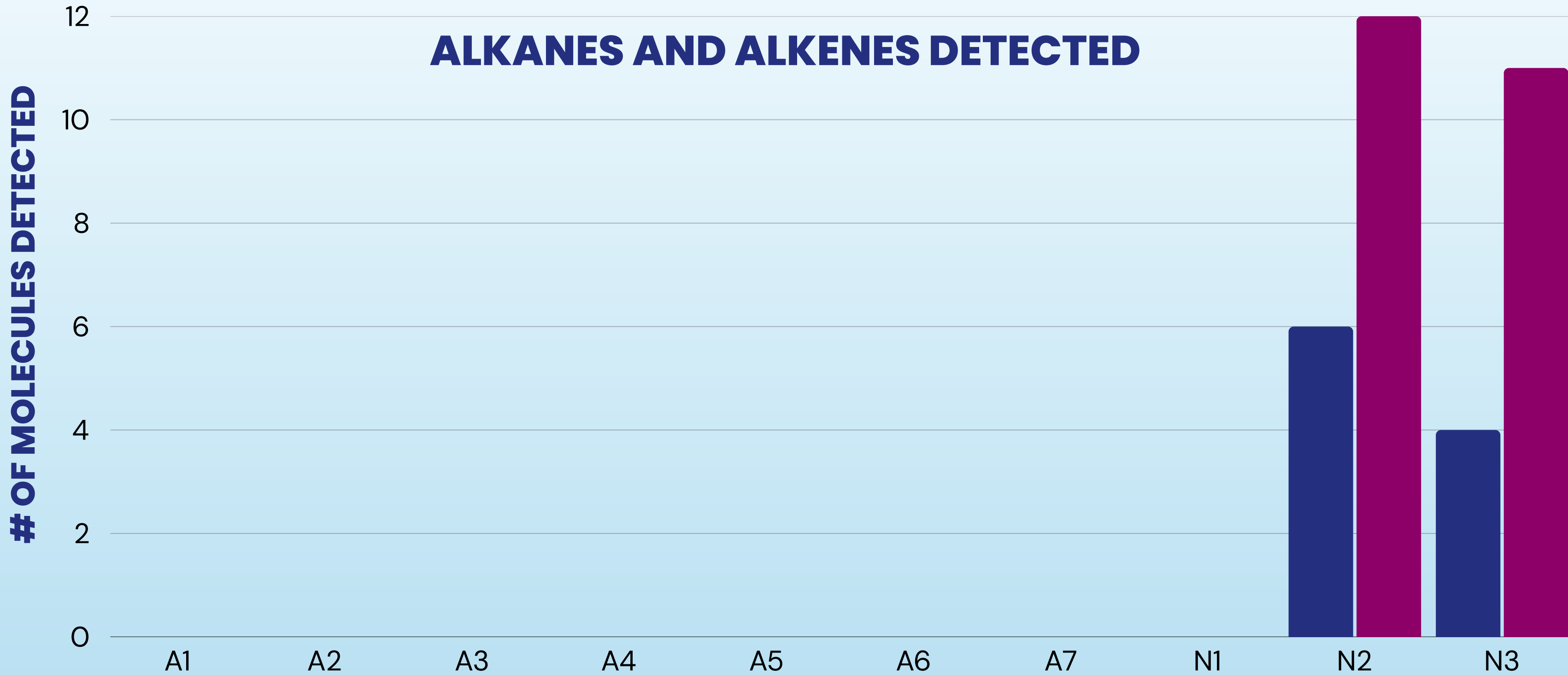
$$\text{R}^1-\text{C}(=\text{O})-\text{O}\cdot\text{H}$$
$$+ \begin{array}{c} \text{CH}_3 \quad \text{OH} \\ | \quad / \\ \text{H}_3\text{C}-\text{N}^+-\text{CH}_3 \\ | \\ \text{CH}_3 \\ \text{TMAH} \end{array}$$

$$+ \begin{array}{c} \text{CH}_3 \\ | \\ \text{N} \\ / \quad \backslash \\ \text{H}_3\text{C} \quad \text{CH}_3 \end{array}$$
$$+ \text{H}-\text{O}-\text{H}$$

RESULTS

PYRO: 600°C & 850°C



● Pyro 600 ● PY850



RESULTS

PYRO: 600°C & 850°C

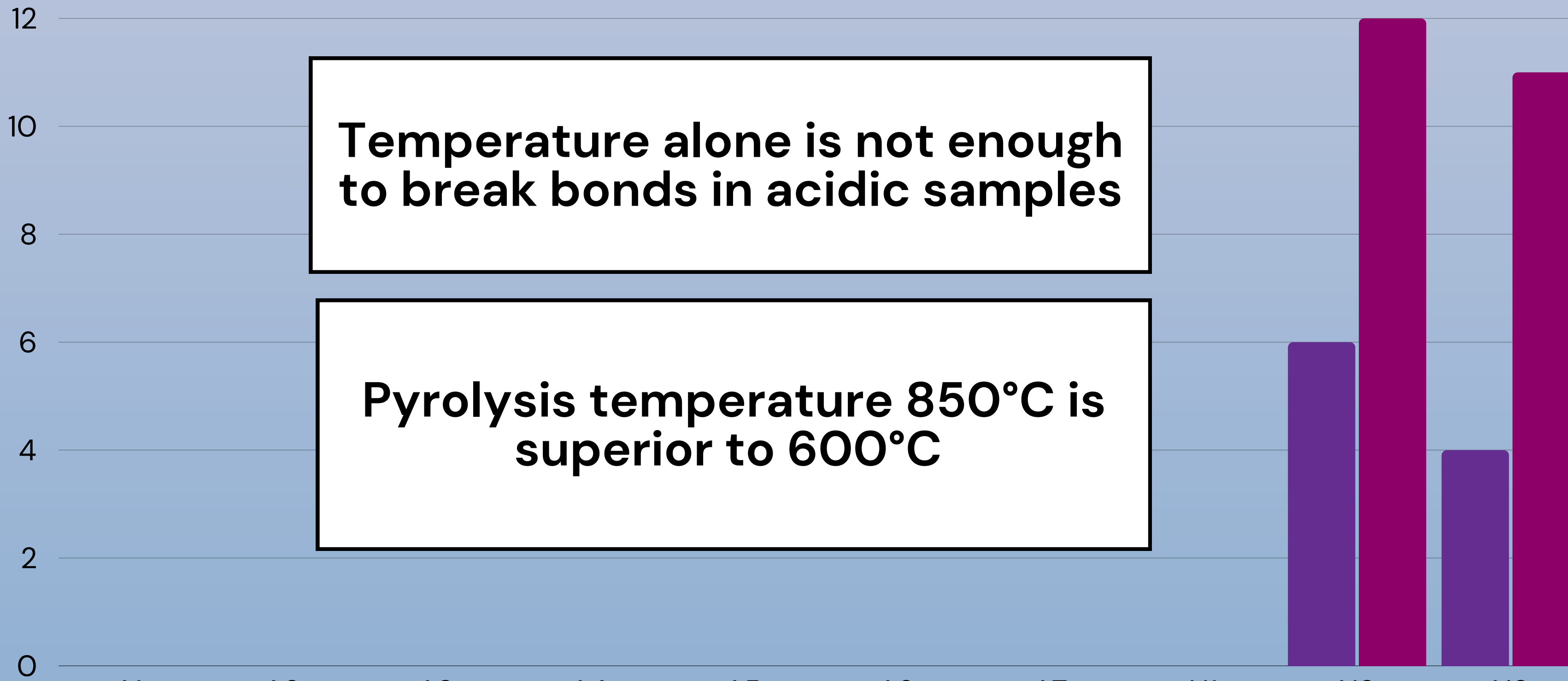
ALKANES AND ALKENES DETECTED

● Pyro 600

● PY850



OF ALKANES AND ALKENES DETECTED

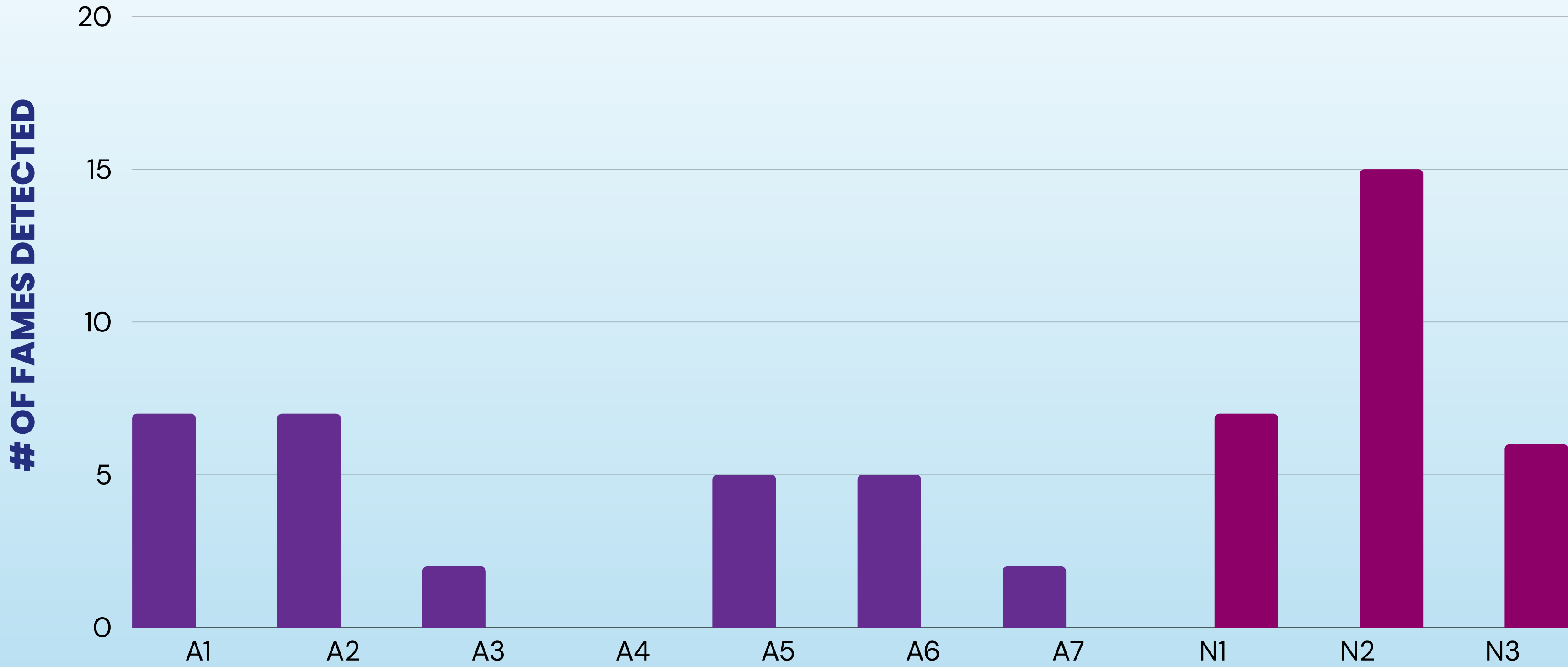


RESULTS

TMAH: FATTY ACID METHYL ESTER



FAMES DETECTED

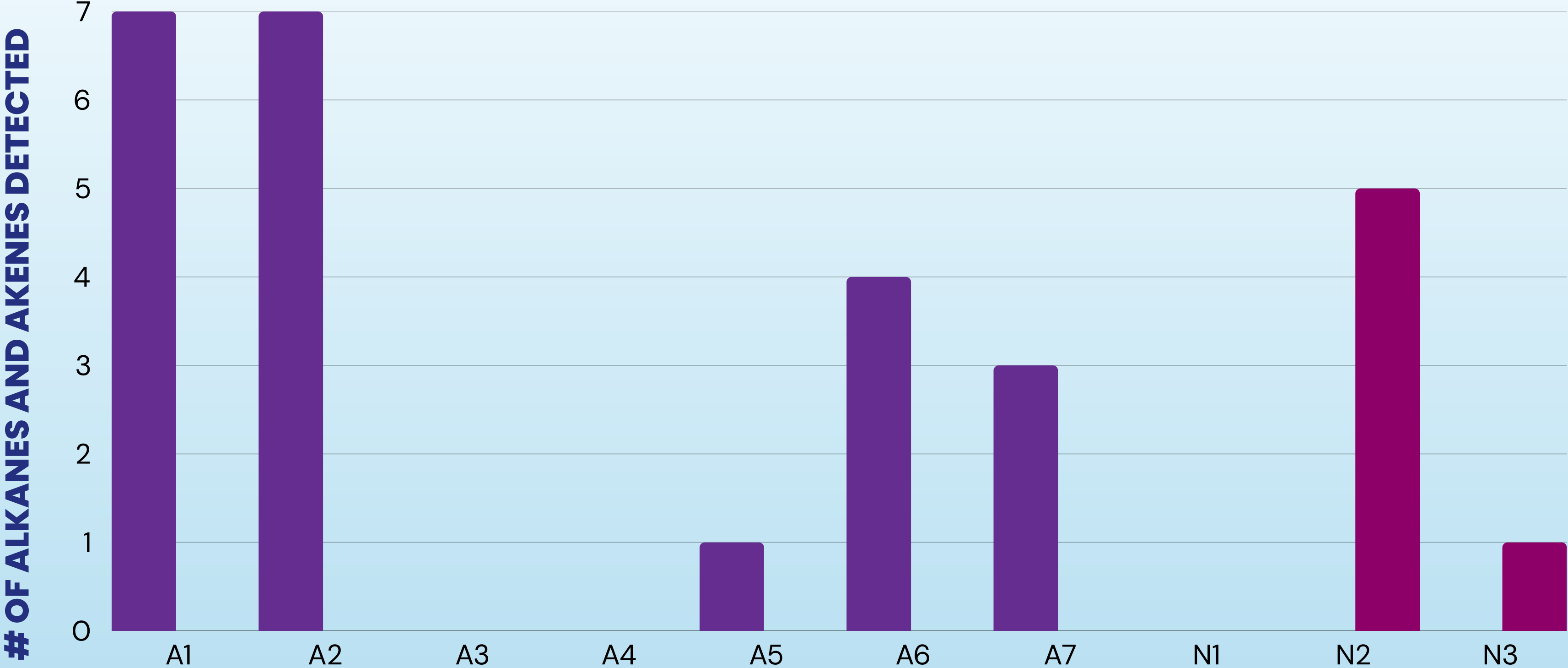


RESULTS

TMAH: ALKANES AND ALKENES

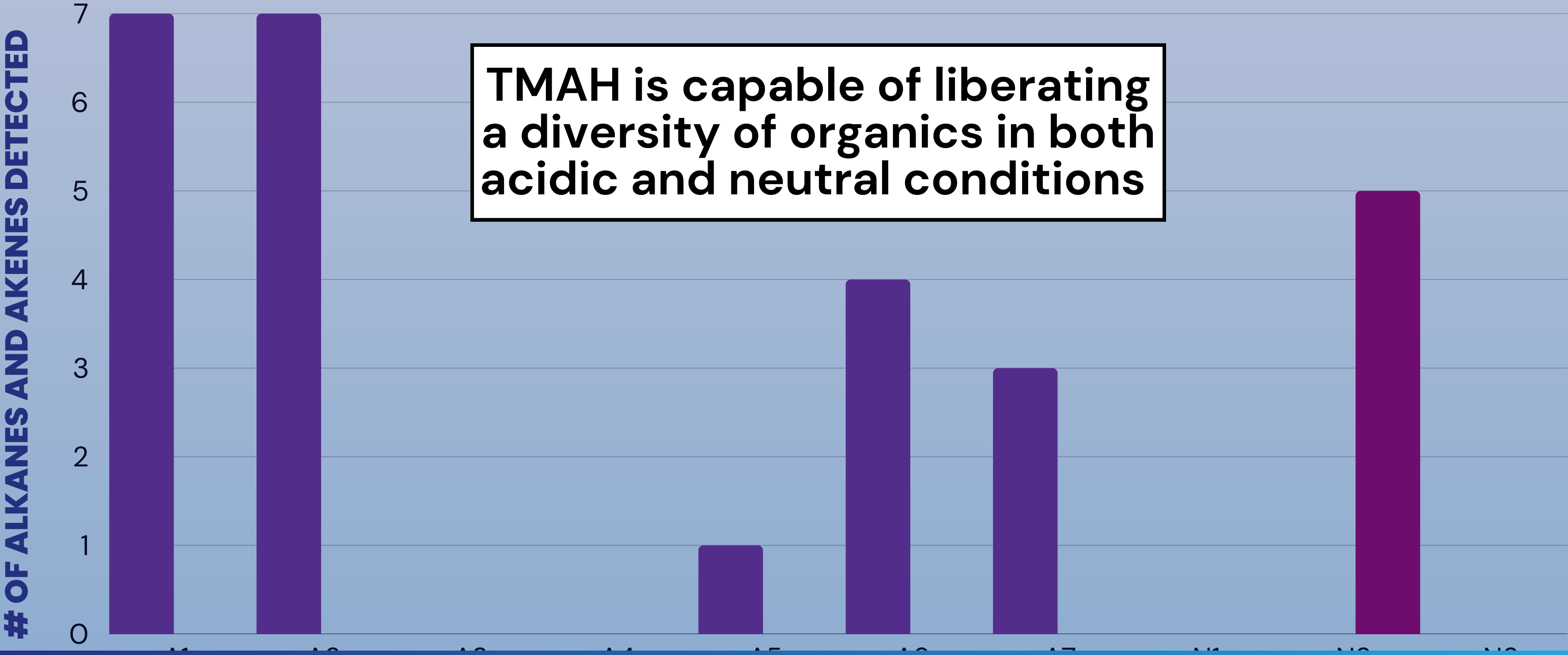


ALKANES AND ALKENES DETECTED



RESULTS

TMAH: ALKANES AND ALKENES

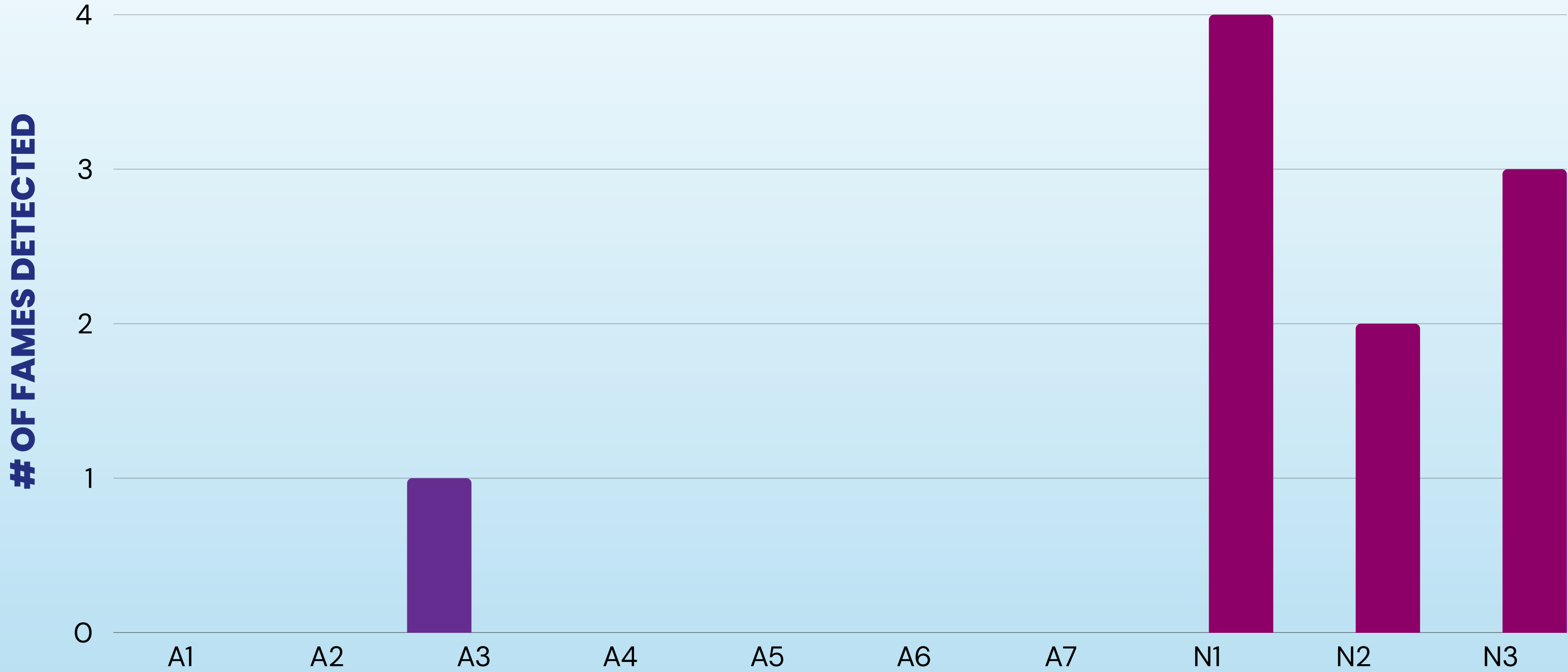


RESULTS

TMSH: FATTY ACID METHYL ESTER



FAMES DETECTED



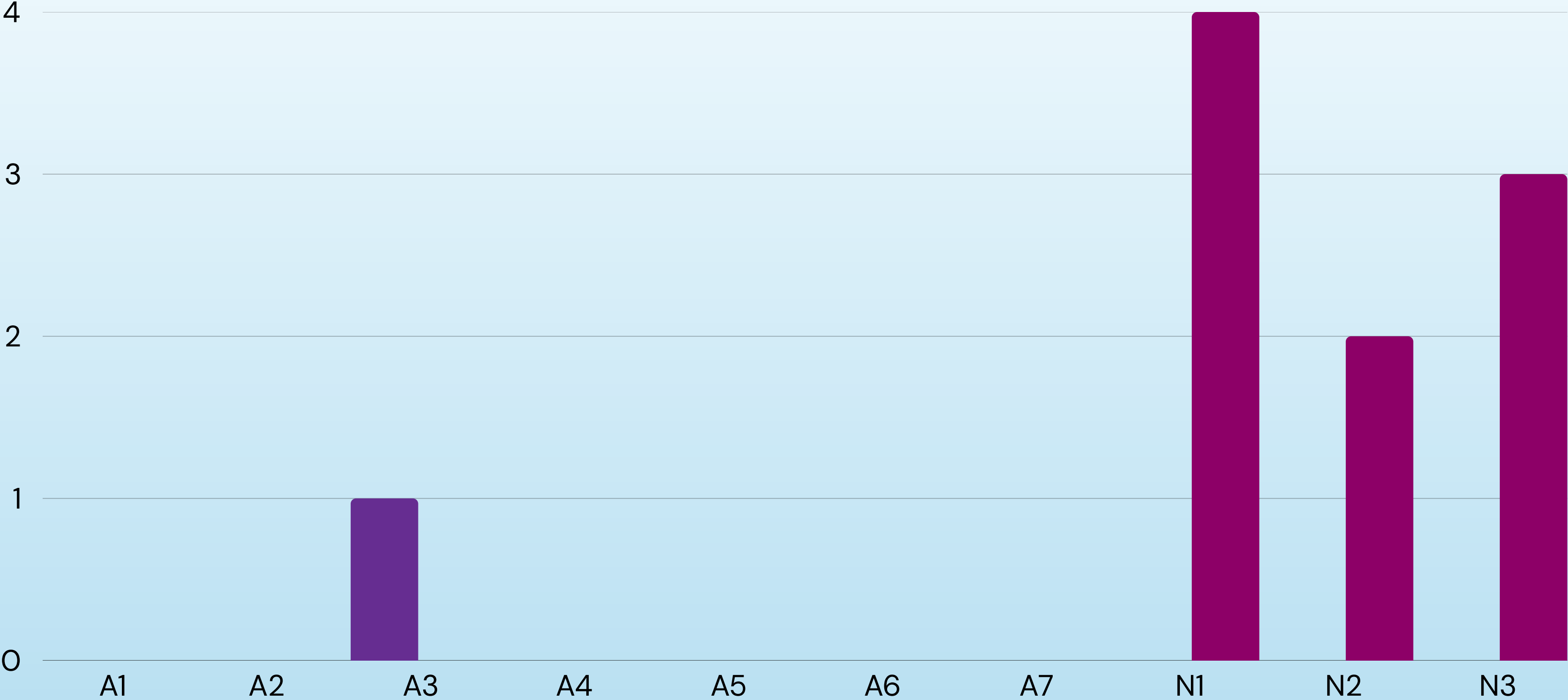
RESULTS

TMSH: ALKANES AND ALKENES



ALKANES AND ALKENES DETECTED

OF ALKANES AND AKENES DETECTED

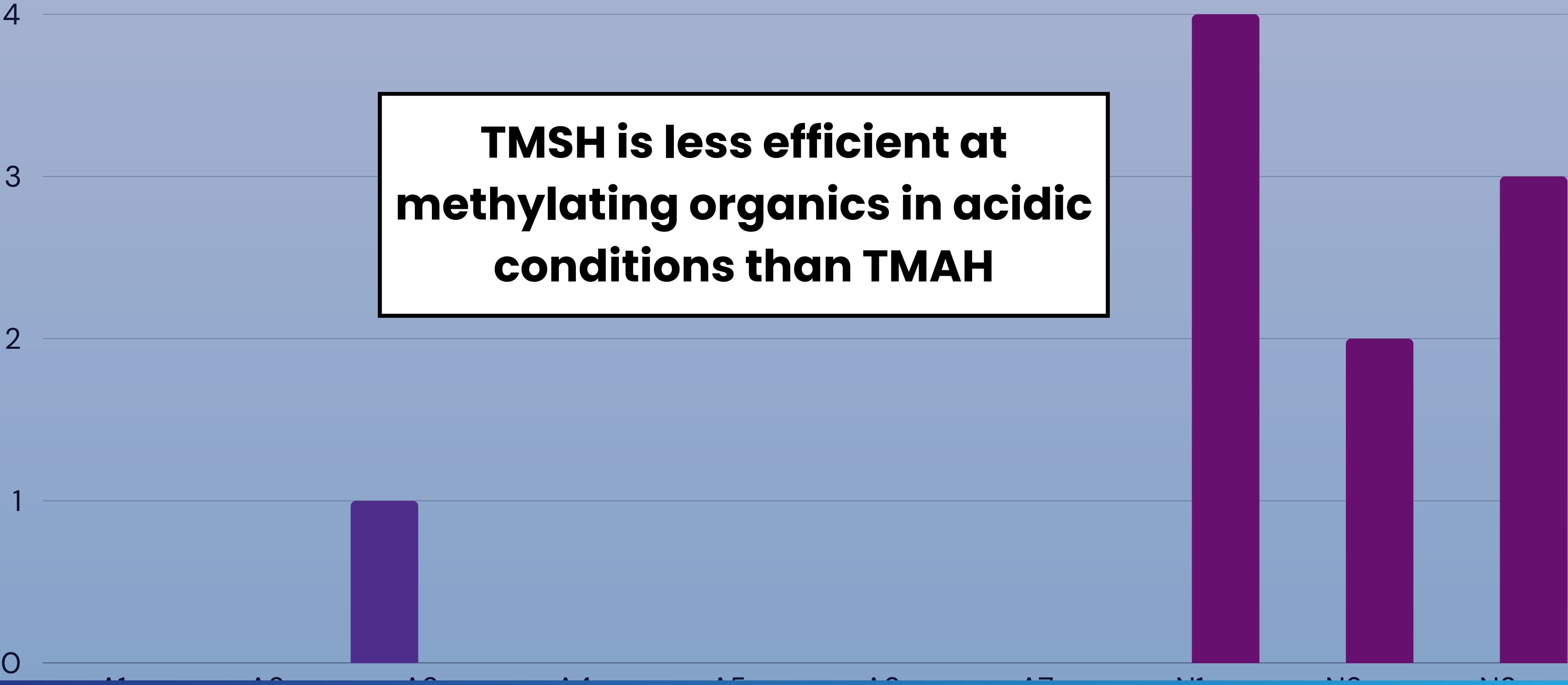


RESULTS

TMSH: ALKANES AND ALKENES



OF ALKANES AND AKENES DETECTED



RESULTS

TMAH: RAMPED PYROLYSIS 35°C/MIN



FAMES DETECTED

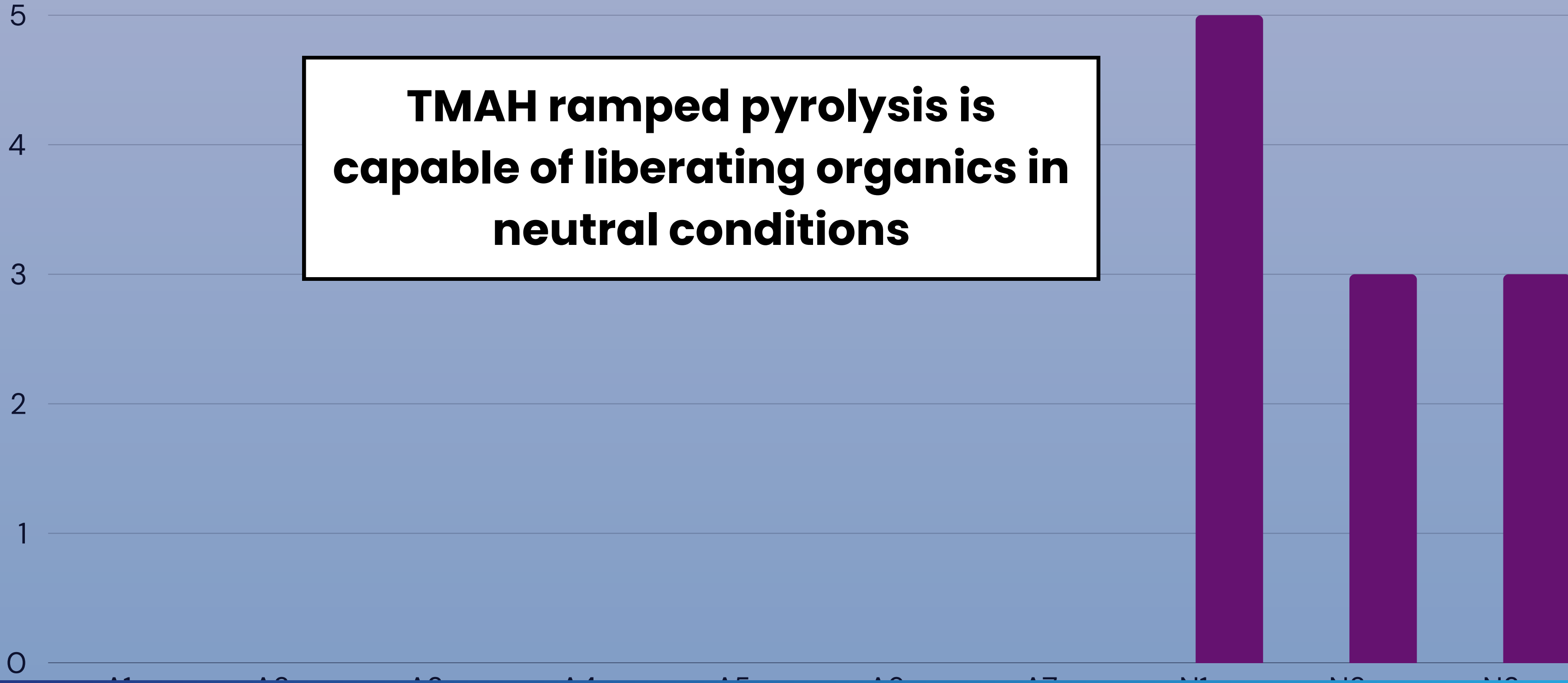


RESULTS

TMAH: RAMPED PYROLYSIS 35°C/MIN



OF FAMES DETECTED



TMAH ramped pyrolysis is capable of liberating organics in neutral conditions

Results Summary

Total carbon content and mineralogy play a key role in biosignature preservation. But these results show that there are other factors that enhance the detection of biosignatures.



Neat vs Reagent

Using a thermochemolysis reagent is more effective than heat alone



Fatty acids vs Alkanes

Fatty acids and hydrocarbons such as alkanes and alkenes are readily detectable in both acidic and circumneutral environments



TMAH vs TMSH

TMAH exhibits superior performance in detecting both alkanes and fatty acids



Ramp vs Flash

Flash pyrolysis outperforms ramped pyrolysis in the detection of biosignatures

FUTURE MARS RESEARCH

ESA Rosalind Franklin ExoMars
Rover landing site is Oxia Planum



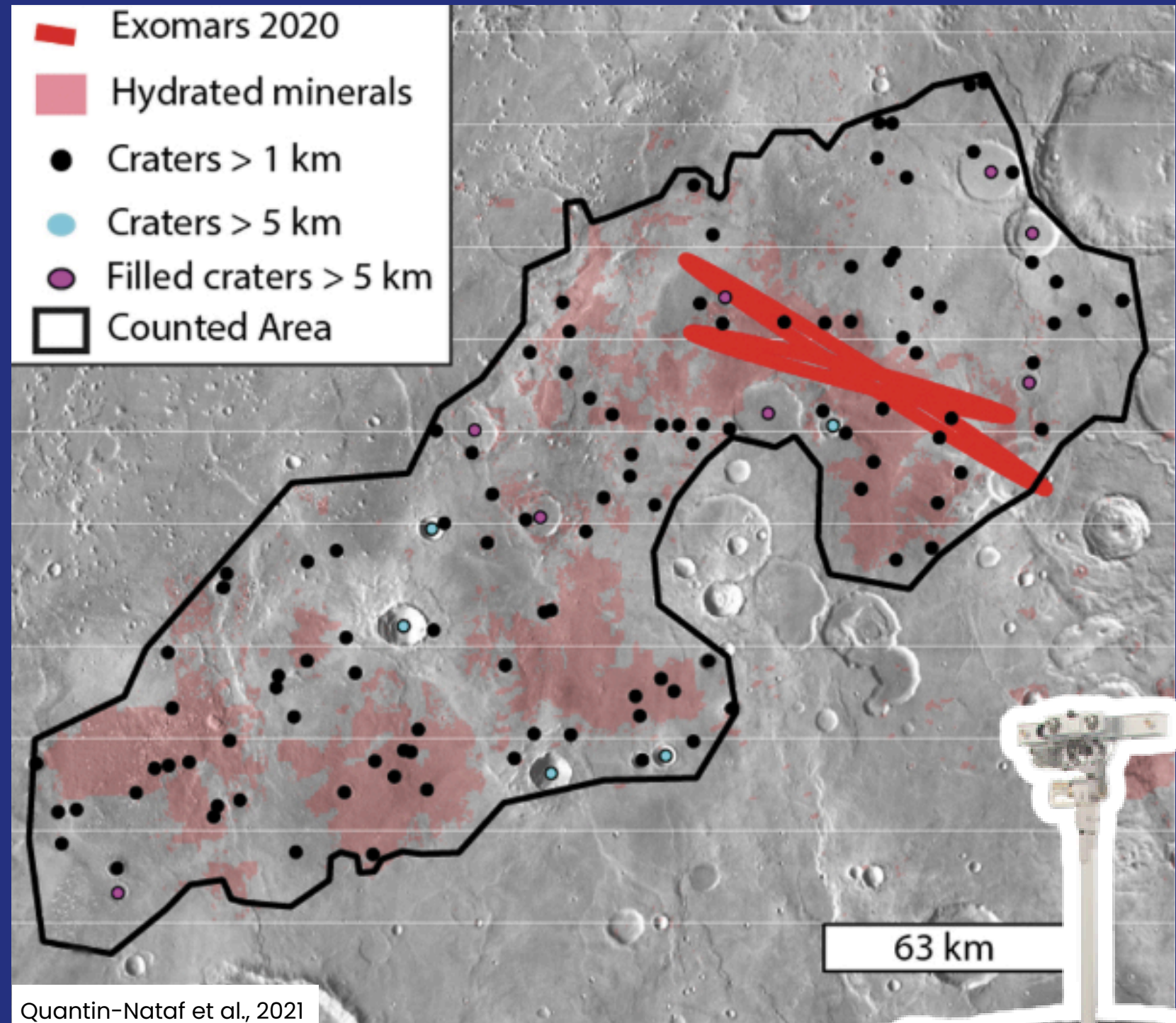
Acidic or Neutral



Flash Pyrolysis



TMAH



THANK YOU

FOR YOUR ATTENTION



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Dr. Amy Williams



Dr. Kathleen Craft

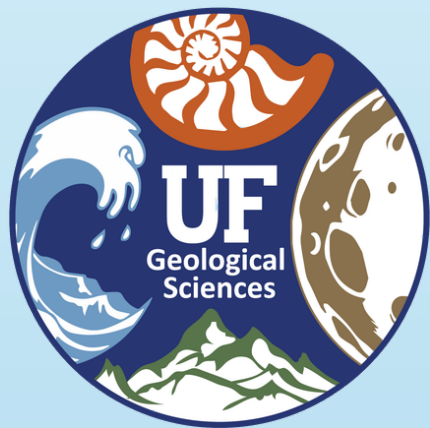


Dr. JR Skok

SCAN ME



 gantgeo.org



Financial support for sample collection was provided by the NASA Planetary Science and Technology through Analog Research (PSTAR) program grant #NNX15AJ38G to J.R.S. and the American Philosophical Society's Lewis and Clark Fund for Exploration and Field Research in Astrobiology to K.L.C.

Back Up Slides

Iceland Biosignature Preservation

ID	A1	A2	A3	A4	A5`	A6	A7	N1	N2	N3
TC (%)	0.18	0.09	0.24	0.1	0.3	0.12	0.14	0.41	0.58	0.58
Mineralogy	Poorly crystalline iron oxide	Poorly crystalline iron oxide	Hydrated iron sulfate Quartz	Goethite Quartz	Goethite	Goethite Quartz	Goethite Quartz	Calcite	Opal-A	Amorphous
FAMES	7	7	2		5	5	2	7	15	6
Alkanes & Alkenes	7	7			1	4	3		12	1