eman ta zabal zazu
Universidad del País Vasco
Euskal Herriko Unibertsitatea

ZIENTZIA ETA TEKNOLOGIA FAKULTATEA
FACULTAD DE CIENCIA Y TECNOLOGÍA

IBeA
Ikertkuntza eta Berrikuntza Analitikoa

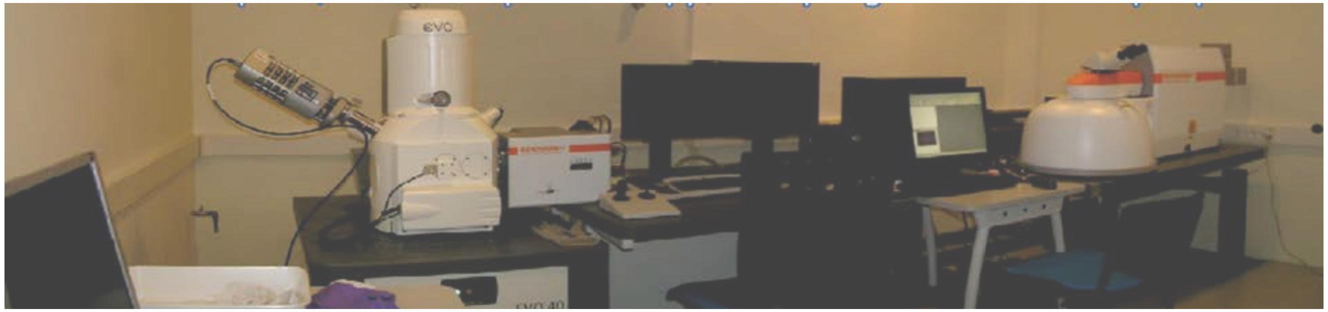
IBeA EN LA EXPLORACIÓN PLANETARIA

Juan Manuel Madariaga

Gorka Arana, Kepa Castro, Julene Aramendia,
Cristina García-Florentino, Jennifer Huidobro, Iratxe Población

Departamento de Química Analítica,
Facultad de Ciencia y Tecnología.

The SCA System of the UPV/EHU (Bilbao) combines the image capability of SEM/ EDX plus µ-Raman Spectroscopy, analysing the same sample point.



Several meteorites (And other minerals) have been analyzed using these instruments with succesful results.

¡No other publications using SCA in meteorites!

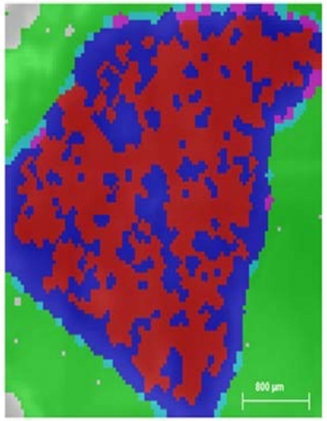
Campo del cielo

Libyan Desert Glass

Darwin Glass
(No other publications before using Raman)

En 2014 la **UPV/EHU** firmó un acuerdo con el **NASA-Johnson Space Center** para estudiar sus Meteoritos de la Antártida

Fragmento de Meteorito EETA 79001



Mass-% (norm.)	Mg	Ca	K	V	Ti	Mn	Cr	Fe	Ni	Zn	Sr	S	P	Si	Al
P1 (red)	0.09	6.77	0.14	0.06	0.42	0.73	0.51	63.4	0	0	0.05	0.54	1.85	25.01	0.36
P2 (green)	0	20.35	8.39	1.6	1.97	2.22	1.77	6.02	2.23	2.96	9.53	1.09	0.39	0.43	0.01
P3 (blue)	0	5.66	0.41	0.11	0.43	1.09	0.7	80.5	0.06	0.13	0.37	0.6	1.19	7.02	0.06
P4 (turqoise)	0	11.65	3.31	0.81	1.53	2.57	1.44	50.5	0.9	1.57	3.79	0.66	0.26	1.15	0.18
P5 (pink)	0	10.3	1.89	0.35	1.11	2.34	1.11	63	0.44	0.88	1.94	0.99	1.36	4.1	0.26

Agreement between the National Aeronautics and Space Administration and University of the Basque Country (UPV/EHU) for the Loan of Antarctic Meteorite Samples

AUTHORITY AND PARTIES

In accordance with the National Aeronautics and Space Act (51 U.S.C. § 20113), this Loan Agreement is entered into by the National Aeronautics and Space Administration Johnson Space Center, located at Houston, Texas (hereinafter referred to as "NASA" or "JSC") and University of the Basque Country (UPV/EHU) in Leioa, Spain (herein referred to as "the Institution"). NASA, the PI and the Institution may be individually referred to as a "Party" and collectively referred to as the "Parties."

PURPOSE

Antarctic meteorite samples distributed by JSC are provided through the United States Antarctic Meteorite Program which is jointly managed by JSC, the Smithsonian Institution, and the National Science Foundation. The samples are property of the US Government and are under the custody and curatorial control of JSC.

NASA desires to make certain Antarctic Meteorite samples available to the Institution by entering into this Loan Agreement. The Institution proposes to use these Antarctic Meteorite samples to undertake scientific investigations led by its Principal Investigator (the person who performs the investigations, hereinafter referred to as "PI"). These investigations are described in one or more sample requests submitted by the PI to the Antarctic Meteorite Sample Curator at JSC and approved by the Antarctic Meteorite Sample Curator. Once approved, these sample requests are an integral part of this Loan Agreement. JSC approval of the sample request (the award letter) is a prerequisite to the initiation of this Loan Agreement and subsequent loan of the

La Coleccion IBeA de Meteoritos de Marte: Preparando las misiones
Tenemos 14 meteoritos de Marte, conocidos como SNC (Shergotty, Nakhla y Chassigny):

Shergotitas son rocas basálticas. Tenemos 10 meteoritos

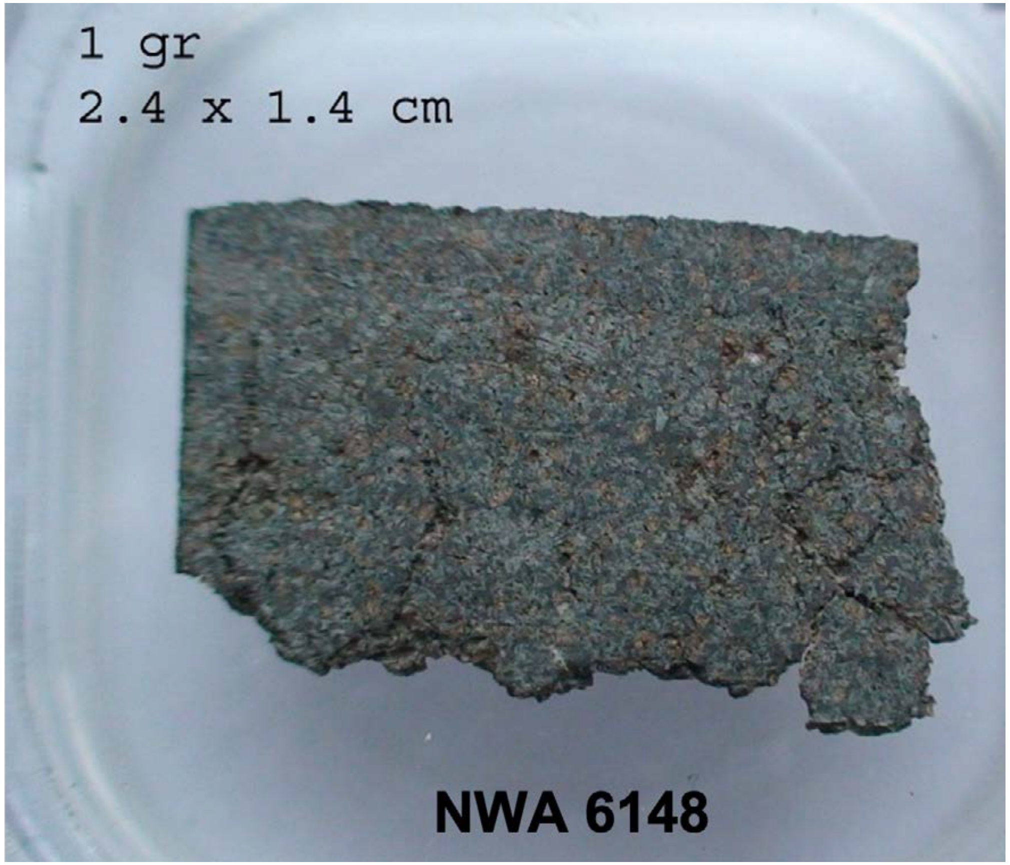
- · **NWA 856**, Basaltic Shergottite
- · **NWA 2975,** Enriched Basaltic Shergottite
- · **Dar al Gani 476 (DaG 489)** Depleted Olivine Orthopyroxene-Phyric Shergottite
- · **Tissint** Martian Shergottite
- · **Zagami,** Martian Shergottite
- · **NWA 1950** SNC Lherzolithic Peridotite
- · **NWA 4468**, Enriched Olivine-phryic Shergottite
- · **Dar al Gani 735,** Depleted Olivine-phryic Shergottite
- · **NWA 1068**, Olivine-phryic Shergottite

Nakhlites son olivino-clinopiroxenos. Tenemos 3 meteoritos

- · **NWA 6148**, Nakhlite
- · **NWA 817**, Nakhlite
- · **NWA 867**, Nakhlite

Chassignites son dunitas. Tenemos 1 de los 2 especímenes existentes

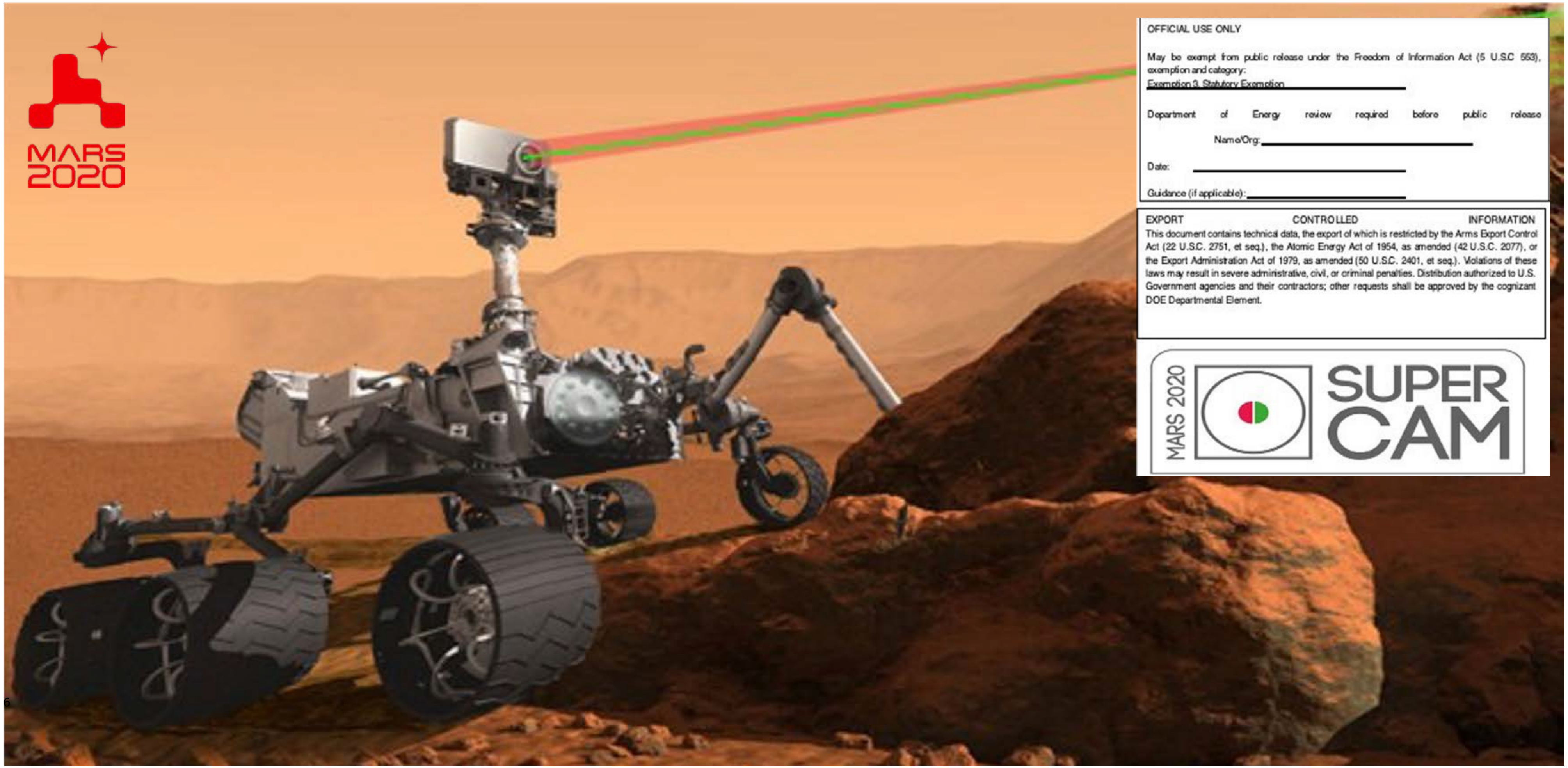
- · **NWA 2737**, Diderot, Chassignite



01
CRONOLOGÍA DE LA MISIÓN MARS 2020
MARS 2020 MISIOAREN KRONOLOGIA

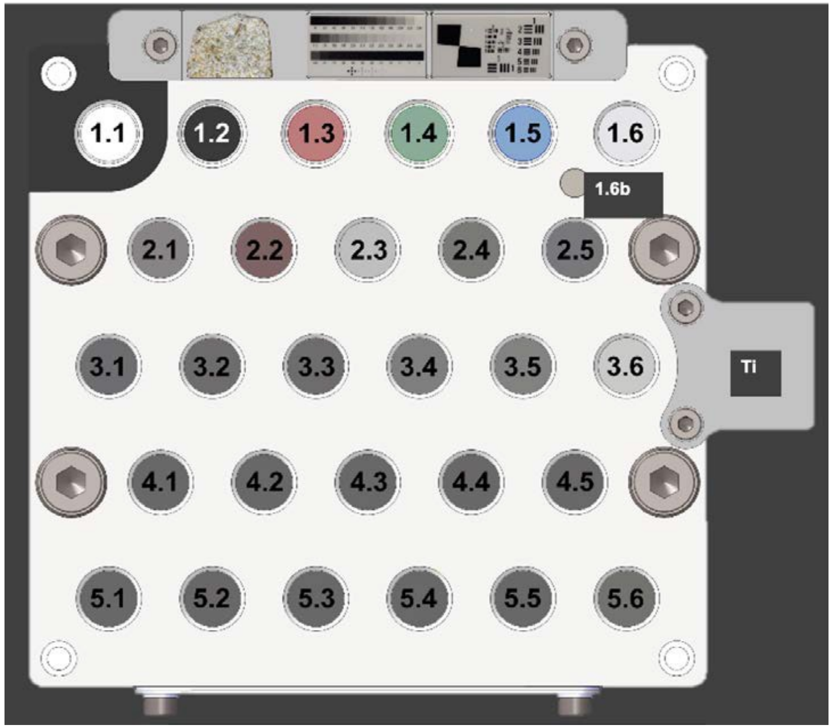
Enero 2015 – SuperCam, Mars2020

En enero de 2015 entramos en el Equipo de Ciencia de Mars2020 a través del instrumento SuperCam

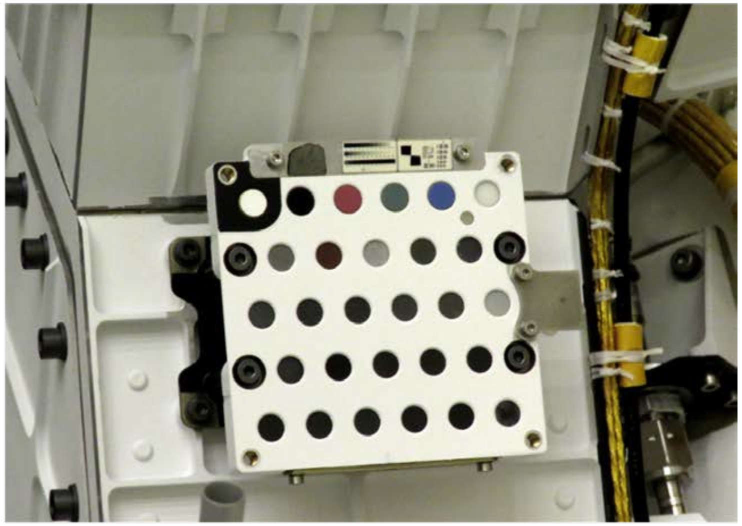


Febrero 2015 - Febrero 2019

Diseño y construcción de la tarjeta de calibrado de SuperCam (SCCT)/Mars2020.

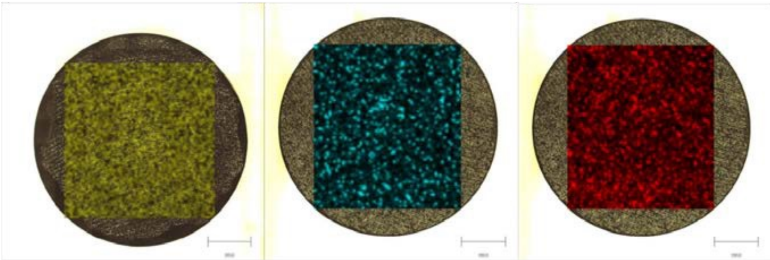


White (Aluwhite98)	VISIR
Black (AeroglazeZ307)	VISIR
Red (LUCIDEON)	RMI
Green (LUCIDEON)	RMI
Cyan (LUCIDEON)	RMI
Ertalyte organic sample (PET)	Raman
Diamond	Raman
Sulfur rich target (K sulfate)	LIBS +
Chert	LIBS +
Calcite (Ca Carbonate)	LIBS +
Ferrosilite (orthopyroxene)	LIBS +
Apatite (phosphate)	LIBS +
Orthoclase (feldspar)	LIBS +
Diopside (Clinopyroxene)	LIBS +
Olivine (silicate)	LIBS +
Andesine (plagioclase)	LIBS +
Enstatite (pyroxene)	LIBS +
Serpentine	LIBS +
Basalt BHVO2	LIBS +
Soil analog JSC-1	LIBS +
Ankerite (Ca, Fe, Mg, Mn carbonate)	LIBS +
Siderite	LIBS +
MN1 (manganese nodule standard)	LIBS +
Glasses doped in Li, Cr, Mn, Ni, Cu, Zn, Rb, Sr, Ba	LIBS
Shergottite synth. glass (ChemCam)	LIBS
Mars meteorite NWA10170	RMI
Geometric target 1 (gray scale)	RMI
Geometric target 2 (USAF)	RMI
Metal plate for wavelength calibration	LIBS



Febrero 2015 - Febrero 2019

Nuestra contribución: Verificar la homogeneidad de las muestras geoquímicas.



Magnetita Cuarzo Calcita

Imagen de micro-espectroscopia Raman de la muestra de Ankerita (SCCT)

$$3(Ca,Fe)(CO_3)_2 + CaSiO_3 + \frac{1}{2}O_2 \rightarrow 4CaCO_3 + Fe_3O_4 + 2\,CO_2 + SiO_2$$


Contents lists available at ScienceDirect
Analytica Chimica Acta
journal homepage: www.elsevier.com/locate/aca

Homogeneity assessment of the SuperCam calibration targets onboard rover perseverance

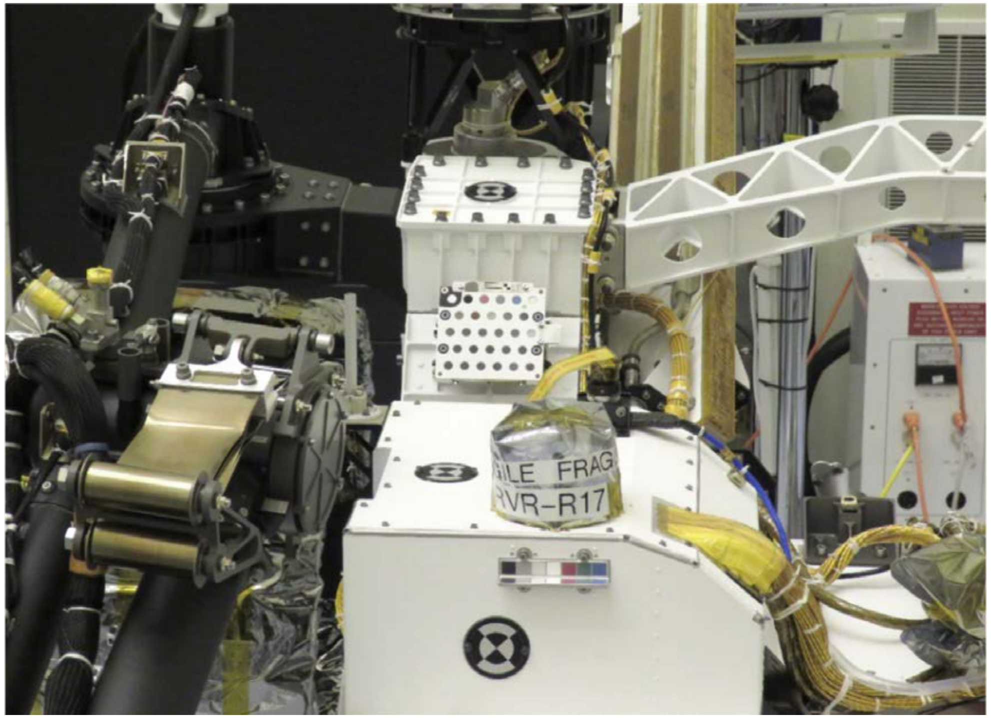
J.M. Madariaga[a,*], J. Aramendia[a], G. Arana[a], K. Castro[a], L. Gómez-Nubla[a], S. Fdez-Ortiz de Vallejuelo[a], C. Garcia-Florentino[a], M. Maguregui[a], J.A. Manrique[b], G. Lopez-Reyes[b], J. Moros[c], A. Cousin[d], S. Maurice[d], A.M. Ollila[e], R.C. Wiens[e,f], F. Rull[b], J. Laserna[c], V. Garcia-Baonza[g,l], M.B. Madsen[h], O. Forni[d], J. Lasue[d], S.M. Clegg[e], S. Robinson[e], P. Bernardi[i], A.J. Brown[j], P. Caïs[k], J. Martinez-Frias[l], P. Beck[m], S. Bernard[n], M.H. Bernt[d], O. Beyssac[n], E. Cloutis[o], C. Drouet[p], G. Dromart[q], B. Dubois[d], C. Fabre[r], O. Gasnault[d], I. Gontijo[s], J.R. Johnson[t], J. Medina[b], P.-Y. Meslin[d], G. Montagnac[q], V. Sautter[n], S.K. Sharma[u], M. Veneranda[b], P.A. Willis[s]

Febrero 2015 - Febrero 2019

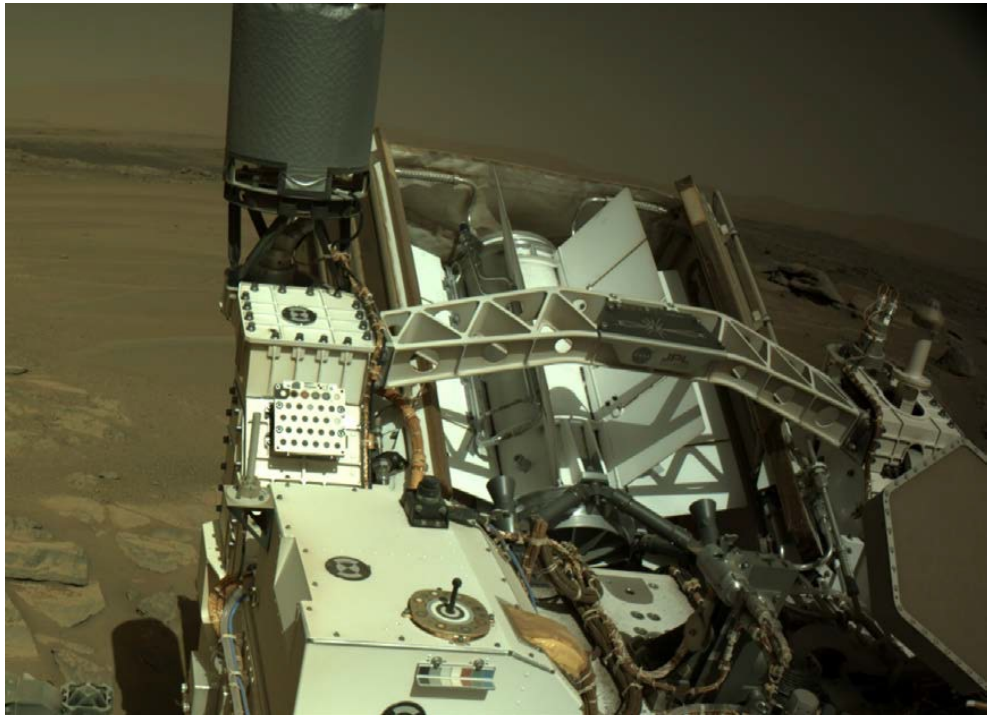
Tarjeta de calibrado de SuperCam (SCCT) / Mars2020 montada y operando en Marte.

MARS 2020

Integración en JPL (14/10/2019)



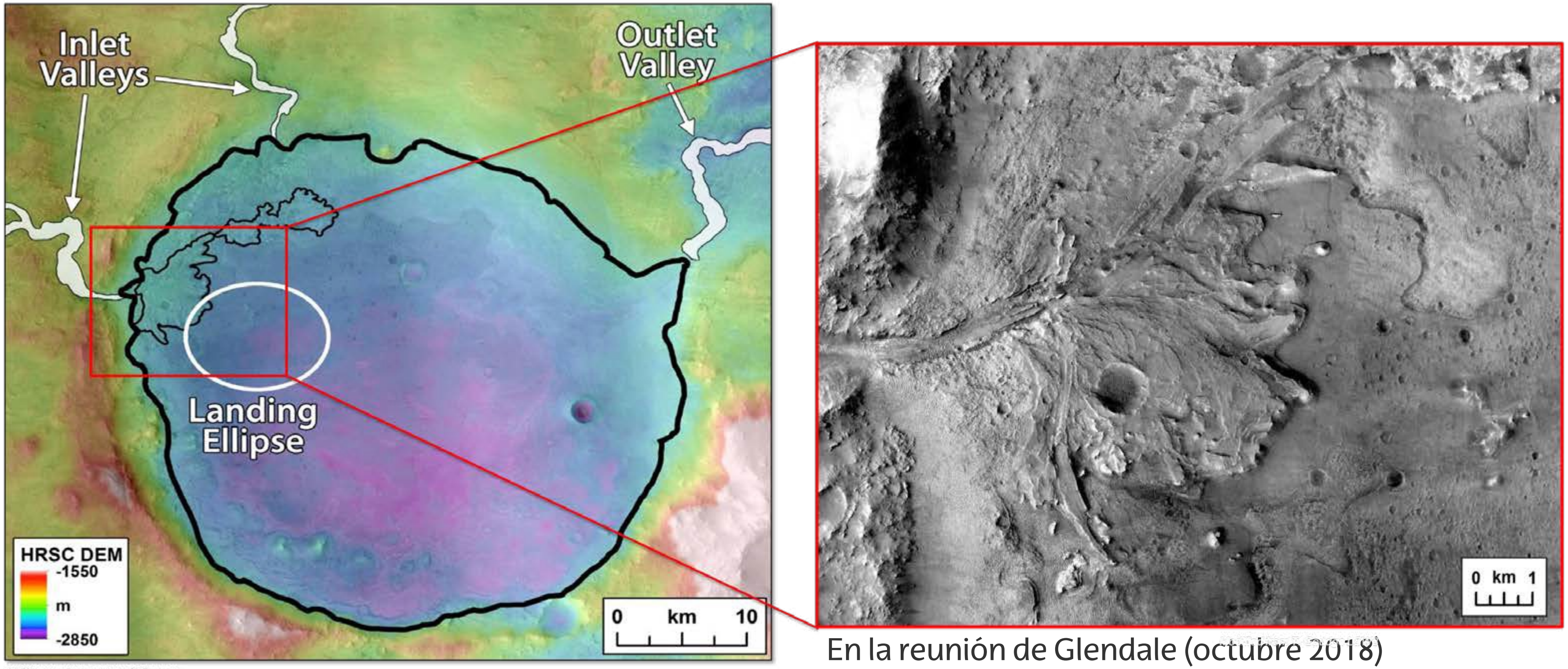
Sol 239 (22/10/2021)



NASA / JPL-Caltech / ASU

Abril 2018 - Octubre 2018

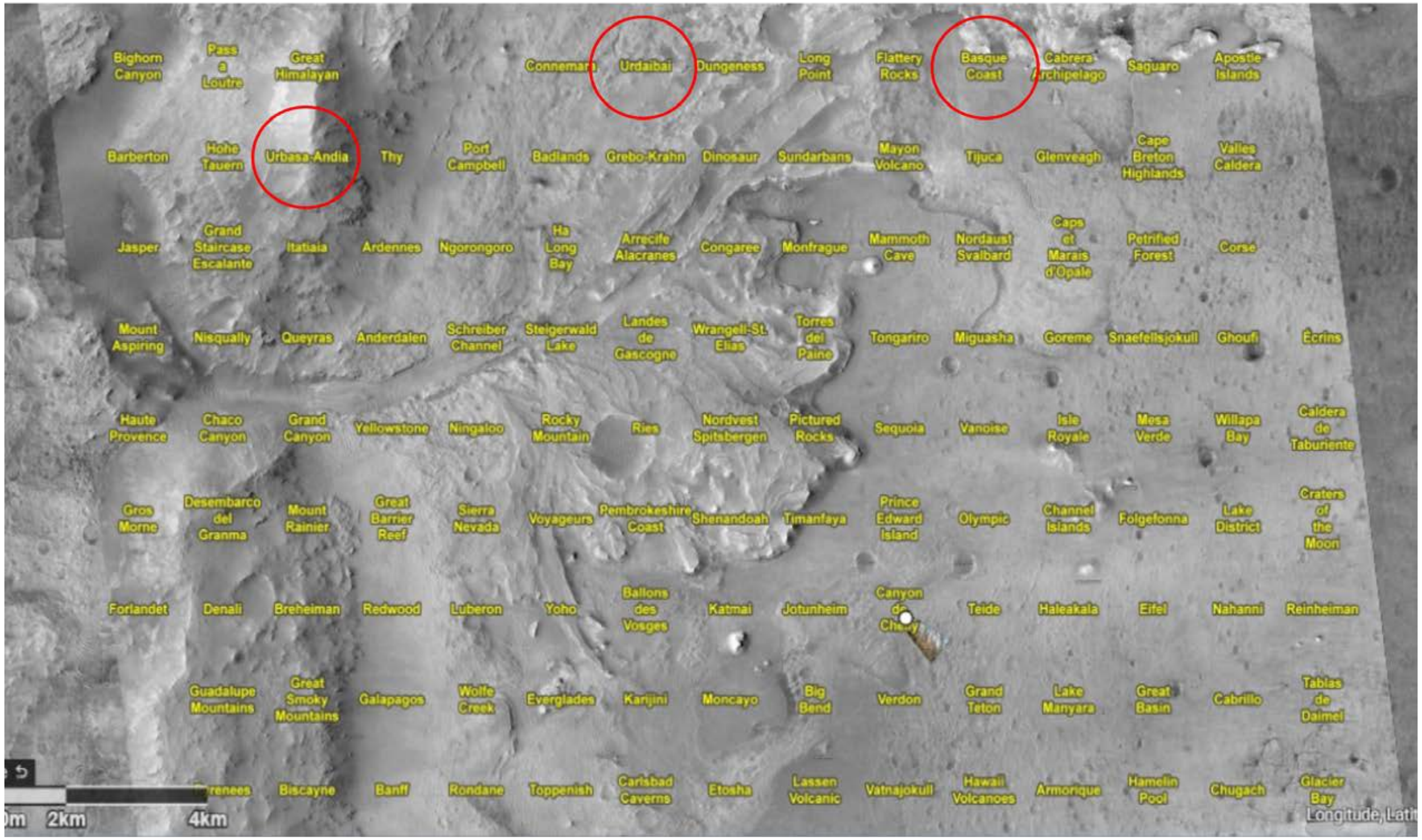
Grupo de trabajo del sitio de aterrizaje de la Misión Mars 2020.



En la reunión de Glendale (octubre 2018)
se eligió al cráter Jezero como el sitio de aterrizaje,
y a Midway como el sitio de la misión extendida.

Abril 2018 - Octubre 2018

Grupo de trabajo del sitio de aterrizaje de la Misión Mars 2020.



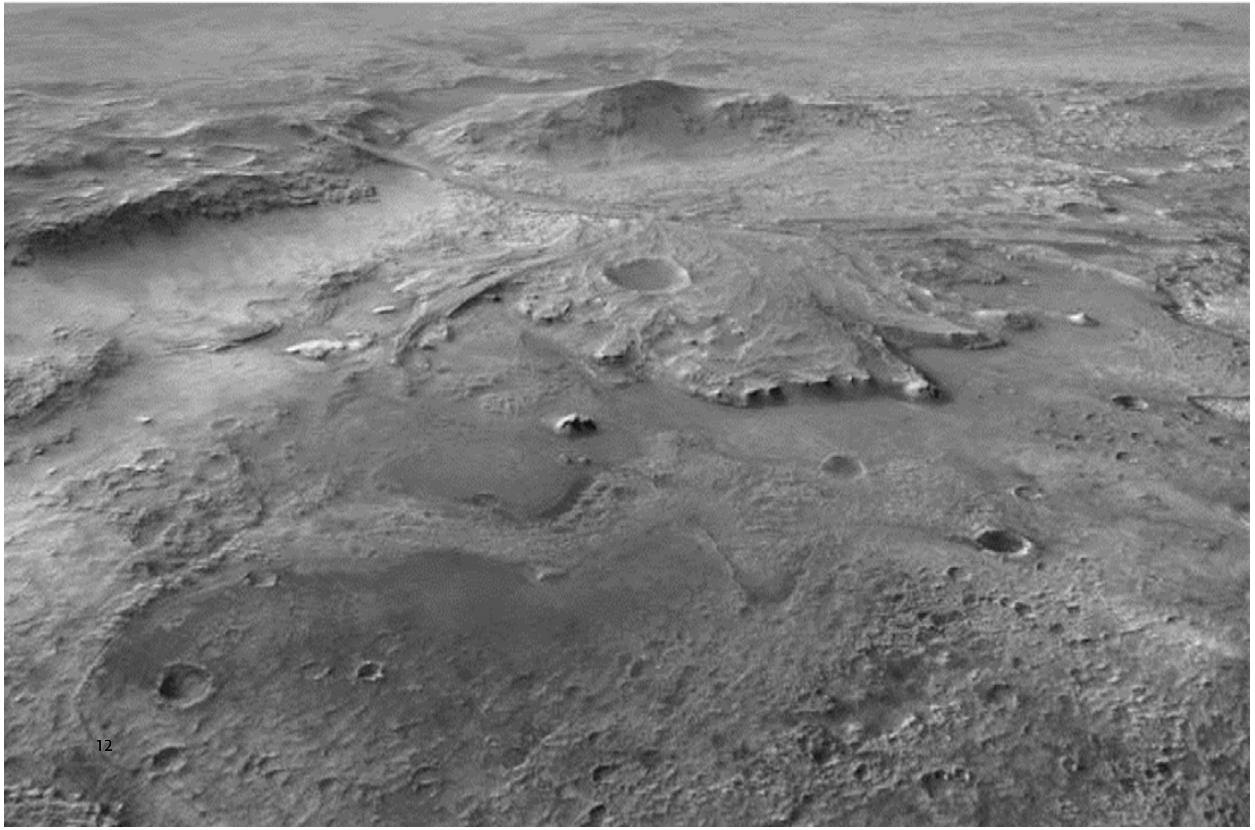
Pusimos nombre a 3 cuadrantes:

- **Urbasa-Andia**
- **Urdaibai**
- **Volcanoes of the Basque Coast**

Abril 2018 - Octubre 2018

Grupo de trabajo del sitio de aterrizaje de la Misión Mars 2020.

Tras armonizar el conjunto de información, se publicó en diciembre de 2020 el mapa de detalle del cráter Jezero, con sus unidades geológicas de interés para conseguir los objetivos de M2020.



Photogeologic Map of the Perseverance Rover Field Site in Jezero Crater Constructed by the Mars 2020 Science Team

Kathryn M. Stack[1] · Nathan R. Williams[1] · Fred Calef III[1] · Vivian Z. Sun[1] · Kenneth H. Williford[1] · Kenneth A. Farley[2] · Sigurd Eide[3] · David Flannery[4] · Cory Hughes[5] · Samantha R. Jacob[6] · Linda C. Kah[7] · Forrest Meyen[8] · Antonio Molina[9] · Cathy Quantin Nataf[10] · Melissa Rice[4] · Patrick Russell[11] · Eva Scheller[2] · Christina H. Seeger[5] · William J. Abbey[1] · Jacob B. Adler[12] · Hans Amundsen[13] · Ryan B. Anderson[14] · Stanley M. Angel[15] · Gorka Arana[16] · James Atkins[7] · Megan Barrington[17] · Tor Berger[18] · Rose Borden[7] · Beau Boring[7] · Adrian Brown[19] · Brandi L. Carrier[1] · Pamela Conrad[20] · Henning Dypvik[3] · Sarah A. Fagents[21] · Zachary E. Gallegos[22] · Brad Garczynski[23] · Keenan Golder[7] · Felipe Gomez[9] · Yulia Goreva[1] · Sanjeev Gupta[24] · Svein-Erik Hamran[3] · Taryn Hicks[7] · Eric D. Hinterman[25] · Briony N. Horgan[23] · Joel Hurowitz[26] · Jeffrey R. Johnson[27] · Jeremie Lasue[28] · Rachel E. Kronyak[1] · Yang Liu[1] · Juan Manuel Madariaga[16] · Nicolas Mangold[29] · John McClean[24] · Noah Miklusicak[7] · Daniel Nunes[1] · Corrine Rojas[6] · Kirby Runyon[27] · Nicole Schmitz[30] · Noel Scudder[23] · Emily Shaver[7] · Jason SooHoo[25] · Russell Spaulding[7] · Evan Stanish[31] · Leslie K. Tamppari[1] · Michael M. Tice[32] · Nathalie Turenne[31] · Peter A. Willis[1] · R. Aileen Yingst[33]

Received: 20 April 2020 / Accepted: 25 September 2020 / Published online: 3 November 2020

Diciembre 2019 y continúa

Grupos de trabajo del instrumento SuperCam de la Misión Mars 2020.

1. Crater Jezero

2. Meñakoz

Diciembre 2019 y continúa

Grupos de trabajo del instrumento SuperCam de la Misión Mars 2020.

ROGER WIENS, INVESTIGADOR PRINCIPAL DEL INSTRUMENTO SUPERCAM, A BORDO DEL ROVER MARS2020 DE LA NASA

«Los más apasionantes serán los descubrimientos inesperados»

ENTREVISTA 26/09/2019

Roger Wiens estuvo en Armintza con miembros del grupo de investigación IBeA. Foto: Mikel Mtnez. de Trespuentes. UPV/EHU

Diciembre 2020 y continúa

SuperCam Mars Operation Center de la Misión Mars 2020.

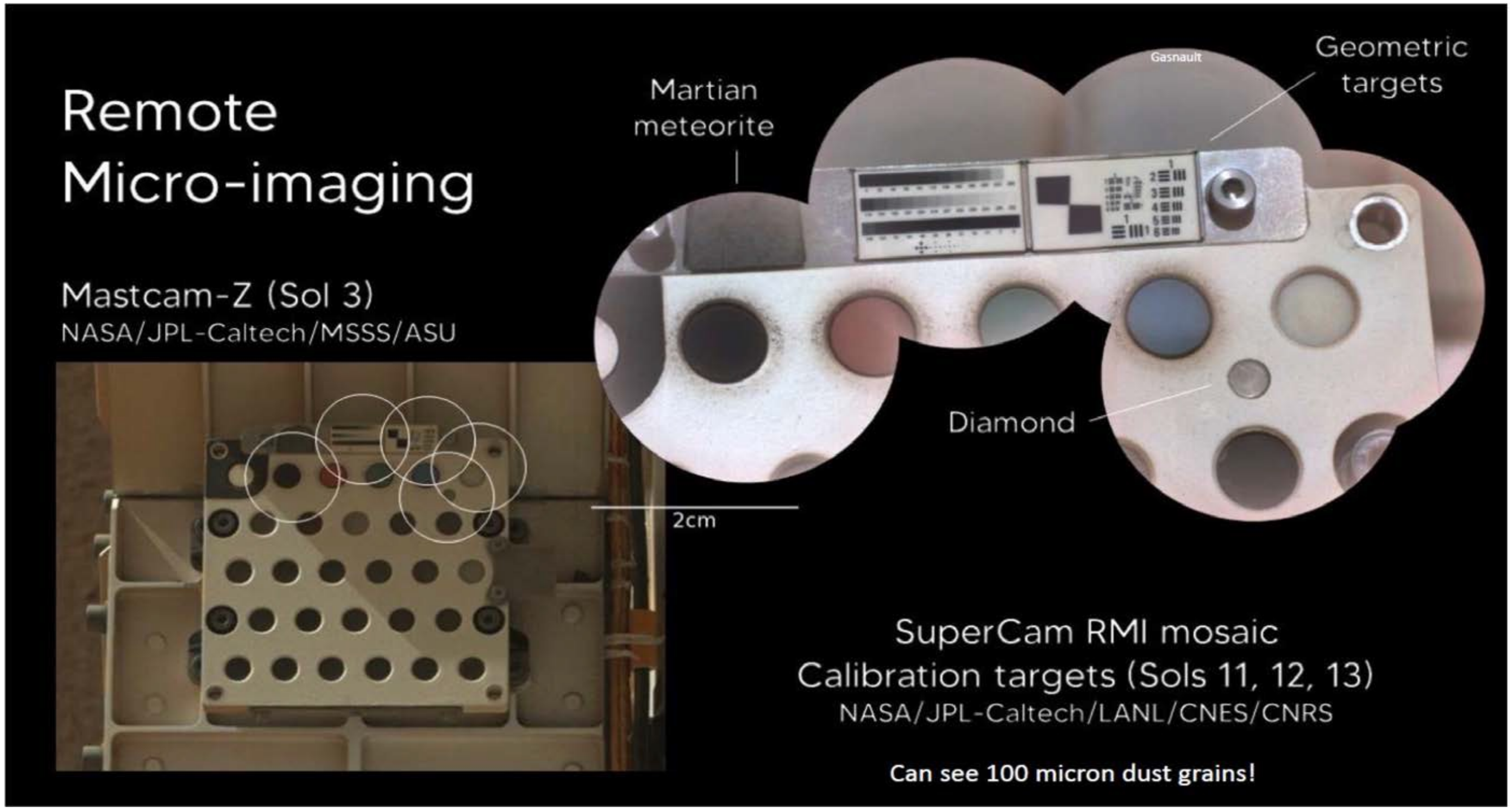
Febrero 2021 y continúa

Misión nominal y extendida de la Misión Mars 2020.

https://mars.nasa.gov/mars2020/multimedia/images/

Febrero 2021 y continúa

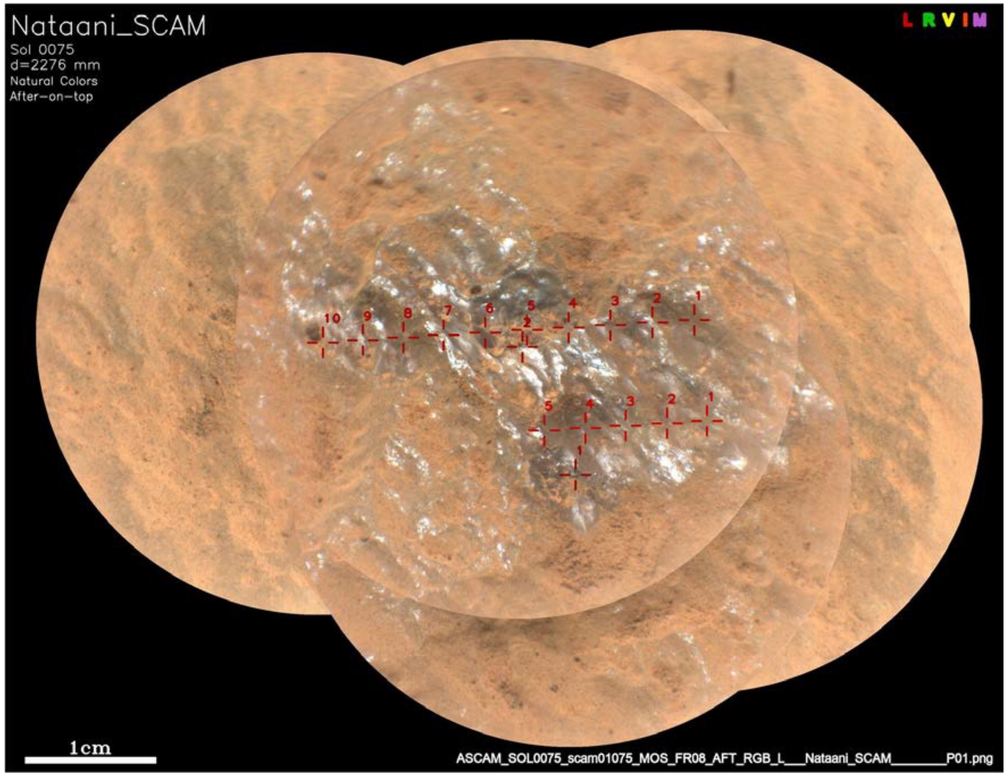
Misión nominal y extendida de la Misión Mars 2020.

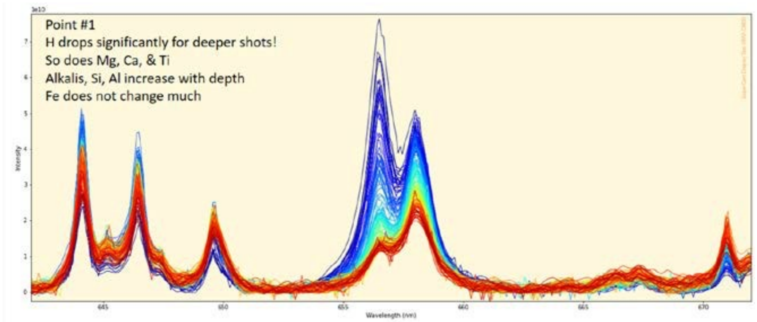


Febrero 2021 y continúa

Misión nominal y extendida de la Misión Mars 2020.

Sol 75.- Primera roca analizada con el conjunto de técnicas de SuperCam





Febrero 2021 y continúa

Misión nominal y extendida de la Misión Mars 2020.

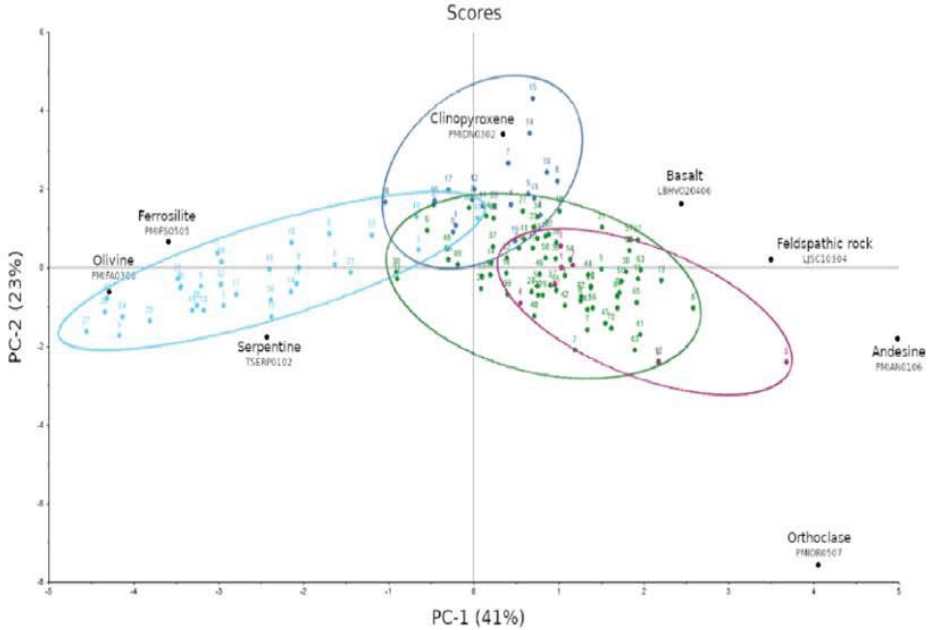
Las primeras publicaciones de SuperCam y de la Misión Mars 2020

SCIENCE ADVANCES | RESEARCH ARTICLE

PLANETARY SCIENCE

Compositionally and density stratified igneous terrain in Jezero crater, Mars

Roger C. Wiens[1]†*, Arya Udry[2], Olivier Beyssac[3], Cathy Quantin-Nataf[4], Nicolas Mangold[5], Agnès Cousin[6], Lucia Mandon[7], Tanja Bosak[8], Olivier Forni[6], Scott M. McLennan[9], Violaine Sautter[3], Adrian Brown[10], Karim Benzerara[3], Jeffrey R. Johnson[11], Lisa Mayhew[12], Sylvestre Maurice[6], Ryan B. Anderson[13], Samuel M. Clegg[1], Larry Crumpler[14], Travis S. J. Gabriel[13], Patrick Gasda[1], James Hall[8], Briony H. N. Horgan[15], Linda Kah[16], Carey Legett IV[1], Juan Manuel Madariaga[17], Pierre-Yves Meslin[6], Ann M. Ollila[1], Francois Poulet[18], Clement Royer[7], Shiv K. Sharma[19], Sandra Siljeström[20], Justin I. Simon[21], Tayro E. Acosta-Maeda[19], Cesar Alvarez-Llamas[22], S. Michael Angel[23], Gorka Arana[17], Pierre Beck[24], Sylvain Bernard[3], Tanguy Bertrand[7], Bruno Bousquet[25], Kepa Castro[17], Baptiste Chide[1], Elise Clavé[25], Ed Cloutis[26], Stephanie Connell[26], Erwin Dehouck[4], Gilles Dromart[4], Woodward Fischer[27], Thierry Fouchet[7], Raymond Francis[28], Jens Frydenvang[29], Olivier Gasnault[6], Erin Gibbons[30], Sanjeev Gupta[31], Elisabeth M. Hausrath[2], Xavier Jacob[32], Hemani Kalucha[27], Evan Kelly[19], Elise Knutsen[33], Nina Lanza[1], Javier Laserna[22], Jeremie Lasue[6], Stéphane Le Mouélic[5], Richard Leveille[30], Guillermo Lopez Reyes[34], Ralph Lorenz[11], Jose Antonio Manrique[34], Jesus Martinez-Frias[35], Tim McConnochie[36], Noureddine Melikechi[37], David Mimoun[38], Franck Montmessin[33], Javier Moros[22], Naomi Murdoch[38], Paolo Pilleri[6], Cedric Pilorget[18], Patrick Pinet[6], William Rapin[6], Fernando Rull[34], Susanne Schröder[39], David L. Shuster[40], Rebecca J. Smith[9], Alexander E. Stott[38], Jesse Tarnas[28], Nathalie Turenne[26], Marco Veneranda[34], David S. Vogt[39], Benjamin P. Weiss[8], Peter Willis[28], Kathryn M. Stack[28], Kenneth H. Williford[28,41], Kenneth A. Farley[27], The SuperCam Team‡



Febrero 2021 y continúa

Misión nominal y extendida de la Misión Mars 2020.

Las primeras publicaciones de SuperCam y de la Misión Mars 2020

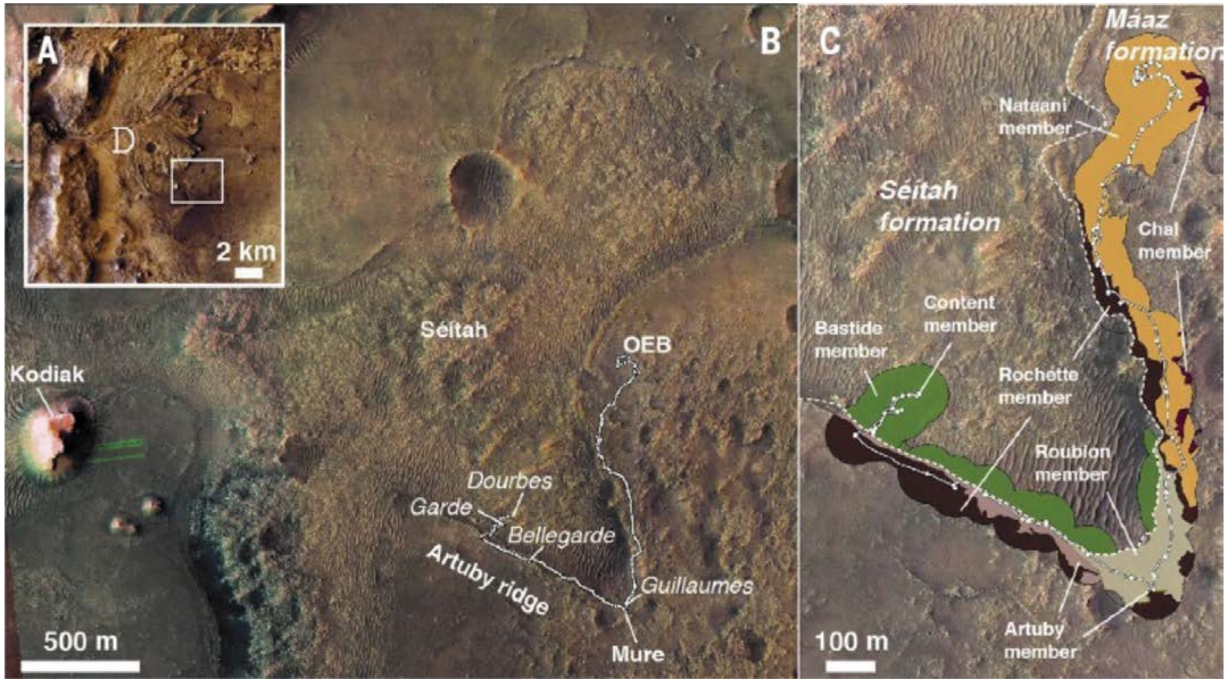
RESEARCH ARTICLE Farley *et al.*, *Science* **377**, eabo2196 (2022) 30 September 2022

MARTIAN GEOLOGY

Aqueously altered igneous rocks sampled on the floor of Jezero crater, Mars

K. A. Farley[1*], K. M. Stack[2], D. L. Shuster[3], B. H. N. Horgan[4], J. A. Hurowitz[5], J. D. Tarnas[2], J. I. Simon[6], V. Z. Sun[2], E. L. Scheller[1], K. R. Moore[1], S. M. McLennan[5], P. M. Vasconcelos[7], R. C. Wiens[8]†, A. H. Treiman[9], L. E. Mayhew[10], O. Beyssac[11], T. V. Kizovski[12], N. J. Tosca[13], K. H. Williford[14], L. S. Crumpler[15], L. W. Beegle[2], J. F. Bell III[16], B. L. Ehlmann[1], Y. Liu[2], J. N. Maki[2], M. E. Schmidt[12], A. C. Allwood[2], H. E. F. Amundsen[17], R. Bhartia[18], T. Bosak[19], A. J. Brown[20], B. C. Clark[21], A. Cousin[22], O. Forni[22], T. S. J. Gabriel[23], Y. Goreva[2], S. Gupta[24], S.-E. Hamran[17], C. D. K. Herd[25], K. Hickman-Lewis[26,27], J. R. Johnson[28], L. C. Kah[29], P. B. Kelemen[30], K. B. Kinch[31], L. Mandon[32], N. Mangold[33], C. Quantin-Nataf[34], M. S. Rice[35], P. S. Russell[36], S. Sharma[2], S. Siljeström[37], A. Steele[38], R. Sullivan[39], M. Wadhwa[16], B. P. Weiss[19,2], A. J. Williams[40], B. V. Wogsland[29], P. A. Willis[2], T. A. Acosta-Maeda[41], P. Beck[42], K. Benzerara[11], S. Bernard[11], A. S. Burton[43], E. L. Cardarelli[2], B. Chide[8], E. Clavé[44], E. A. Cloutis[45], B. A. Cohen[46], A. D. Czaja[47], V. Debaille[48], E. Dehouck[34], A. G. Fairén[49,50], D. T. Flannery[51], S. Z. Fleron[52], T. Fouchet[32], J. Frydenvang[53], B. J. Garczynski[4], E. F. Gibbons[54], E. M. Hausrath[55], A. G. Hayes[50], J. Henneke[56], J. L. Jørgensen[56], E. M. Kelly[41], J. Lasue[22], S. Le Mouélic[33], J. M. Madariaga[57], S. Maurice[22], M. Merusi[31], P.-Y. Meslin[22], S. M. Milkovich[2], C. C. Million[58], R. C. Moeller[2], J. I. Núñez[28], A. M. Ollila[59], G. Paar[60], D. A. Paige[36], D. A. K. Pedersen[56], P. Pilleri[22], C. Pilorget[61,62], P. C. Pinet[22], J. W. Rice Jr.[16], C. Royer[11], V. Sautter[11], M. Schulte[63], M. A. Sephton[24], S. K. Sharma[41], S. F. Sholes[2], N. Spanovich[2], M. St. Clair[58], C. D. Tate[50], K. Uckert[2], S. J. VanBommel[64], A. G. Yanchilina[65], M.-P. Zorzano[50]

The Perseverance rover landed in Jezero crater, Mars, to investigate ancient lake and river deposits. We report observations of the crater floor, below the crater's sedimentary delta, finding that the floor consists of igneous rocks altered by water. The lowest exposed unit, informally named Séítah, is a coarsely crystalline olivine-rich rock, which accumulated at the base of a magma body. Magnesium-iron carbonates along grain boundaries indicate reactions with carbon dioxide–rich water under water-poor conditions. Overlying Séítah is a unit informally named Máaz, which we interpret as lava flows or the chemical complement to Séítah in a layered igneous body. Voids in these rocks contain sulfates and perchlorates, likely introduced by later near-surface brine evaporation. Core samples of these rocks have been stored aboard Perseverance for potential return to Earth.



Mayo 2018 y continúa

Grupo de trabajo de recogida de muestras de la Misión Mars 2020.

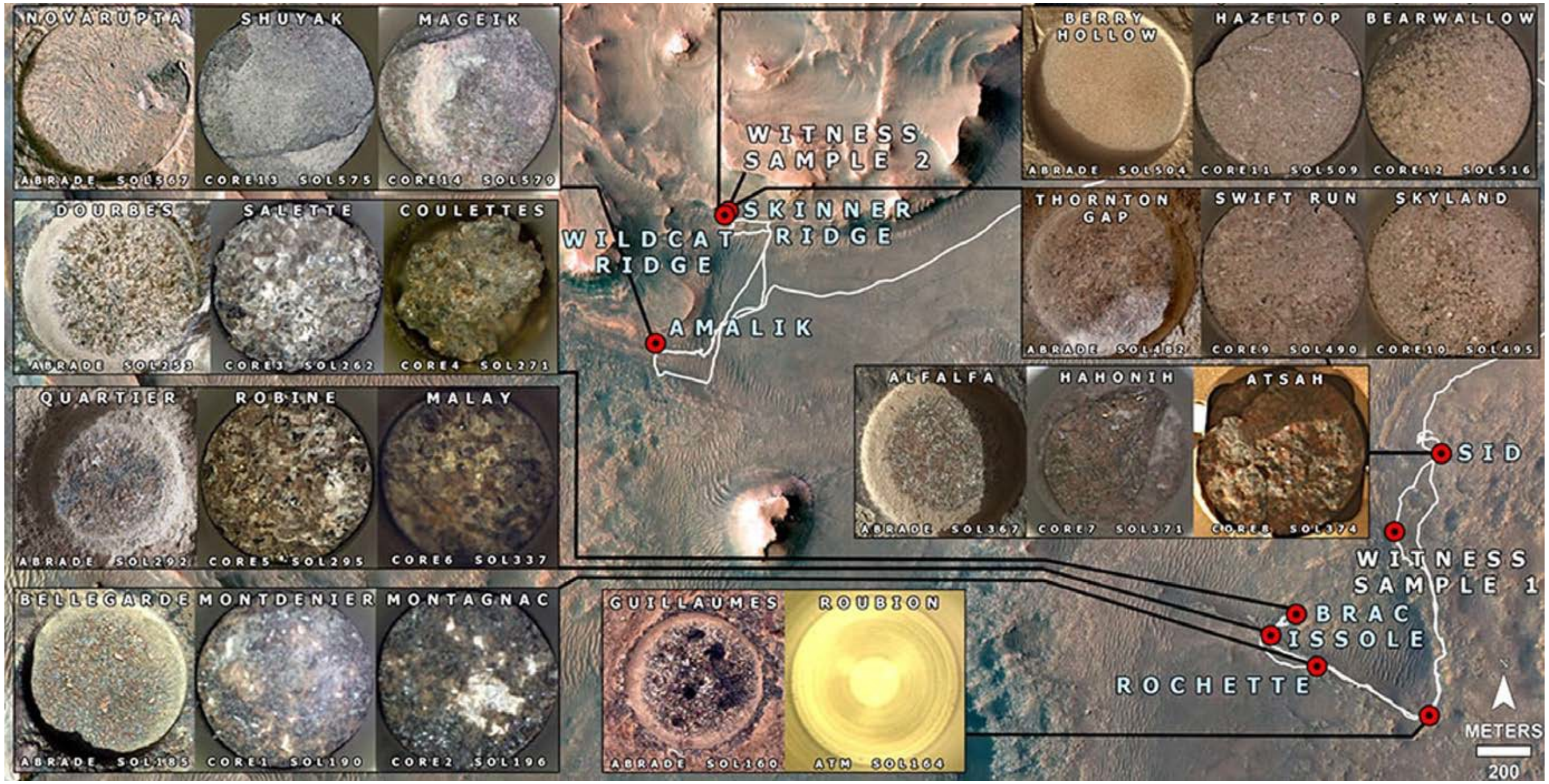
Sol 160.- Guillaume,
Primera roca que se
pule mecánicamente

NASA/JPL-Caltech/ASU

Mayo 2018 y continúa

Grupo de trabajo de recogida de muestras de la Misión Mars 2020.

Sample Collection Map: Cores 1-14



02
MISIONES FUTURAS
ETORKIZUNEKO MISIOAK

Misiones Futuras: Mars Sample Return (MSR)

Preparando el laboratorio para analizar muestras de retorno

ELSEVIER

Contents lists available at ScienceDirect

Talanta

journal homepage: www.elsevier.com/locate/talanta

Development of innovative non-destructive analytical strategies for Mars Sample Return tested on Dar al Gani 735 Martian Meteorite

C. García-Florentino [a,*], I. Torre-Fdez [a], P. Ruiz-Galende [a], J. Aramendia [a], K. Castro [a], G. Arana [a], M. Maguregui [b], S. Fdz Ortiz de Vallejuelo [a], J.M. Madariaga [a]

[a] *Department of Analytical Chemistry, Faculty of Science and Technology, University of the Basque Country UPV/EHU, Barrio Sarriena S/n, 48940, Leioa, Basque Country, Spain*

[b] *Department of Analytical Chemistry, Faculty of Pharmacy, University of the Basque Country UPV/EHU, P.O. Box 450, 01080, Vitoria-Gasteis, Basque Country, Spain*

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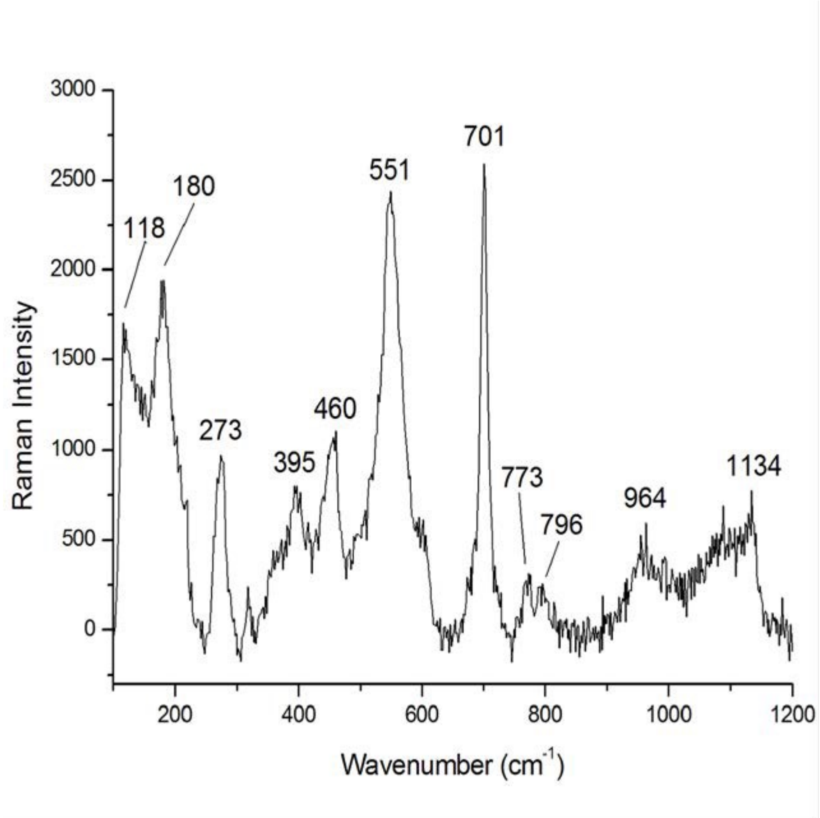
ABSTRACT

This work proposes an innovative non-destructive analytical strategy, based on Confocal Raman micro-spectroscopy, High Resolution Raman Imaging and micro-X-Ray Fluorescence imaging, as part of the quick non-destructive techniques that could be used to characterize the Martian samples from the Mars Sample Return mission when back on Earth. Until that moment, Martian Meteorites are the only Martian samples in our hands to develop such Analytical Strategies. To demonstrate its capabilities, this analytical strategy has been applied to characterize the Dar al Gani 735 Martian Meteorite with the aim to identify the terrestrial and non-terrestrial alterations suffered by the meteorite as a very valuable complementary methodology to the more traditional petrographic analyses and single point measurements. The combination of these techniques allows extracting at the same time elemental, molecular and structural information of the studied area of the sample. The most relevant results on the analyzed DaG 735 shergottite thick samples revealed the presence of several altered mineral phases originated from the temperature and pressure conditions during the shock on Mars (anhydride, calcite and ilmenite), as well as from terrestrial weathering processes that degraded the meteorite from its landing on Earth (calcite and hematite in fractures together with gypsum, mirabilite and thenardite). As most of the conclusive results come from Raman spectroscopy, this study shows the potential of Raman spectroscopy as a key technique in the upcoming new explorations of Mars materials by the Rosalind Franklin rover (Exomars2022 mission from ESA) and the Perseverance rover (Mars2020 mission from NASA), where Raman spectrometers are mounted for the first time in an extra-terrestrial research in the field.

Misiones Futuras: La importancia de los Análogos Terrestres

Las lavas almoadilladas de Meñakoz



Misiones Futuras: La importancia de los Análogos Terrestres

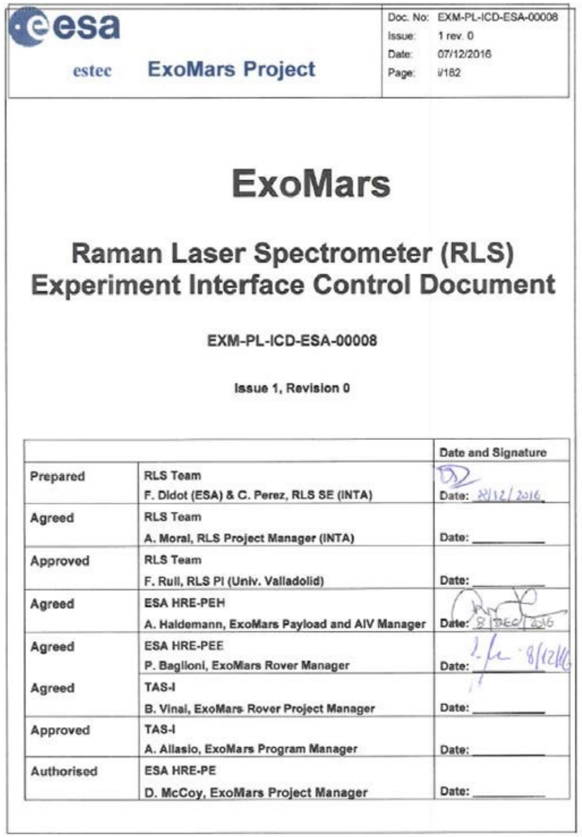
La sucesión de estratos sedimentarios/lavas fluidas de Armintza

Formación Kodiak en el Delta de Jezero

Sucesión estratigráfica en Armintza

Misiones Futuras: ExoMars - Rosalind Franklin

Pertenecemos oficialmente desde 2016 al Instrumento RLS (Raman Laser Spectrometer)



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estec ExoMars Project

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Date: 07/12/2016
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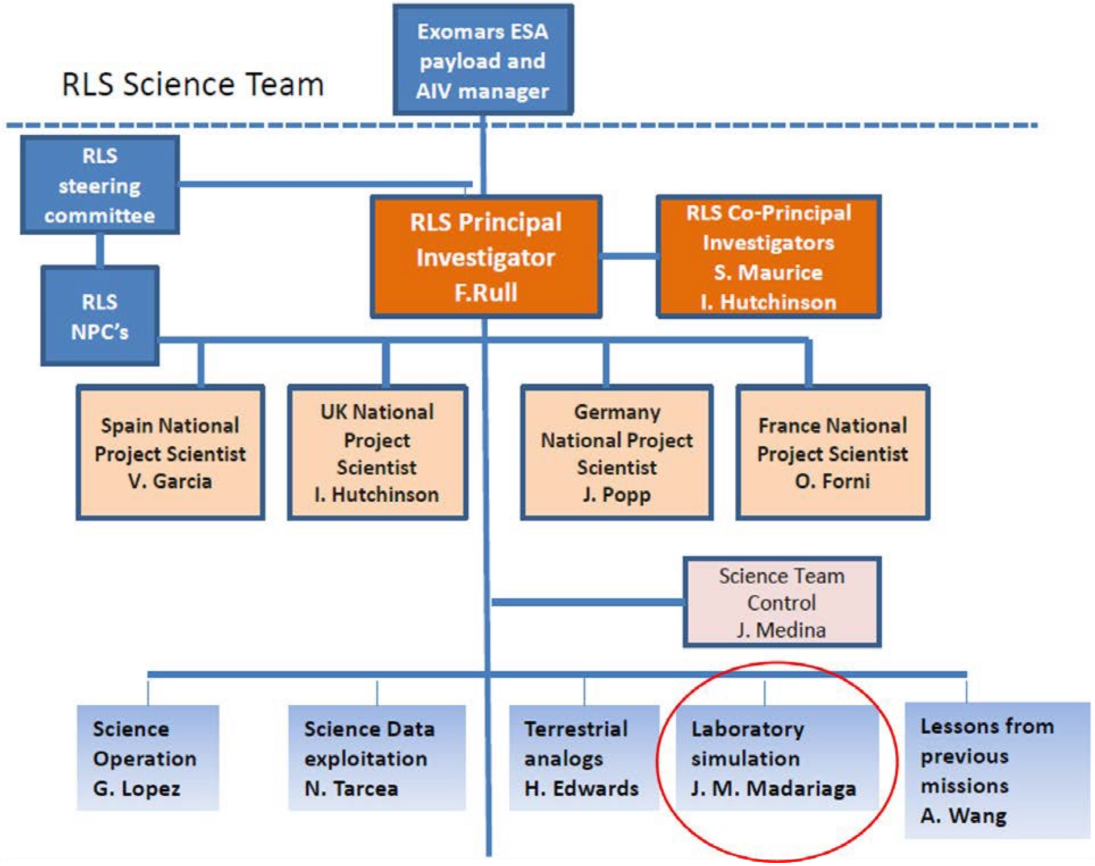
ExoMars

Raman Laser Spectrometer (RLS)
Experiment Interface Control Document

EXM-PL-ICD-ESA-00008

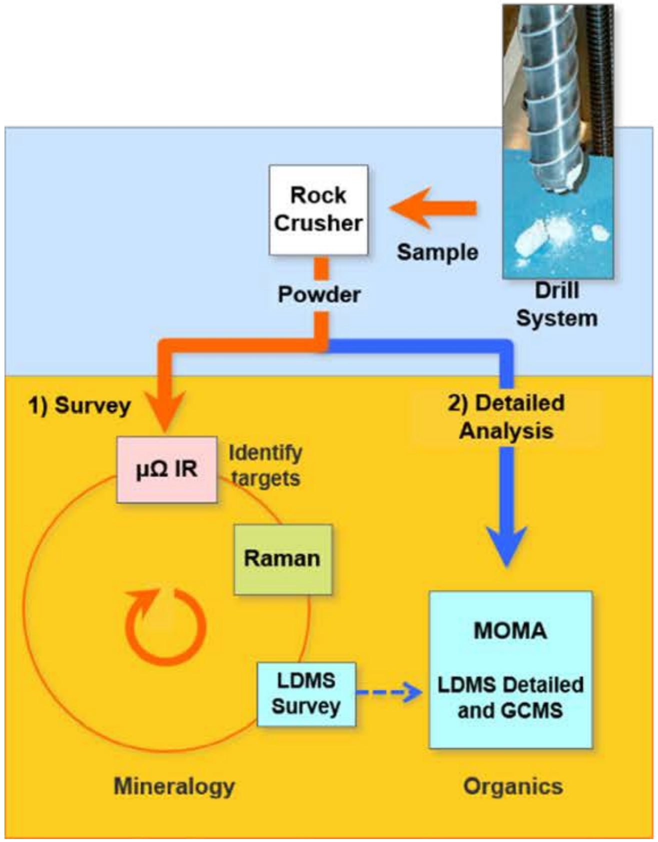
Issue 1, Revision 0

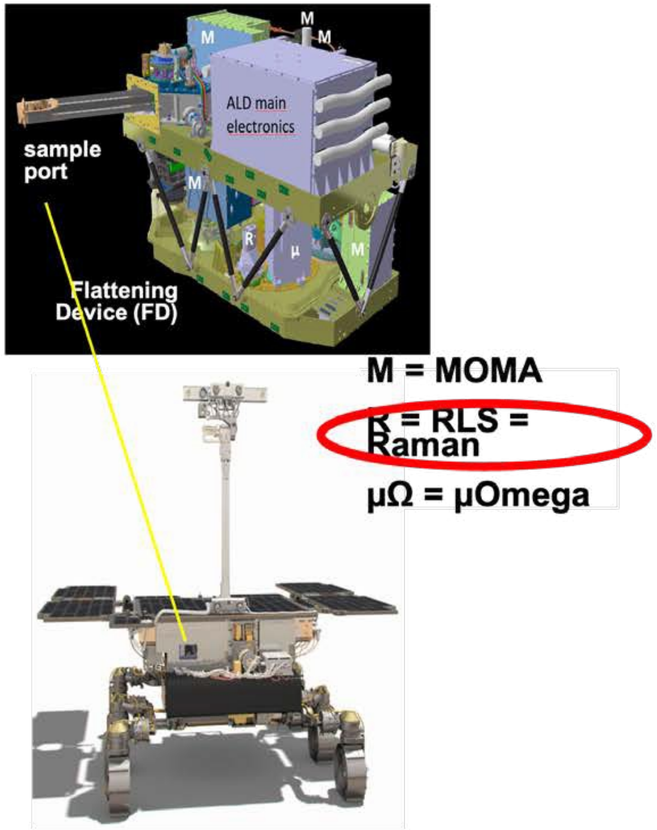
		Date and Signature
Prepared	RLS Team F. Didot (ESA) & C. Perez, RLS SE (INTA)	Date: 7/12/2016
Agreed	RLS Team A. Moral, RLS Project Manager (INTA)	Date:
Approved	RLS Team F. Rull, RLS PI (Univ. Valladolid)	Date:
Agreed	ESA HRE-PEH A. Haldemann, ExoMars Payload and AIV Manager	Date: 8 DEC 2016
Agreed	ESA HRE-PEE P. Baglioni, ExoMars Rover Manager	Date: 8/12/16
Agreed	TAS-I B. Vinai, ExoMars Rover Project Manager	Date:
Approved	TAS-I A. Allasio, ExoMars Program Manager	Date:
Authorised	ESA HRE-PE D. McCoy, ExoMars Project Manager	Date:

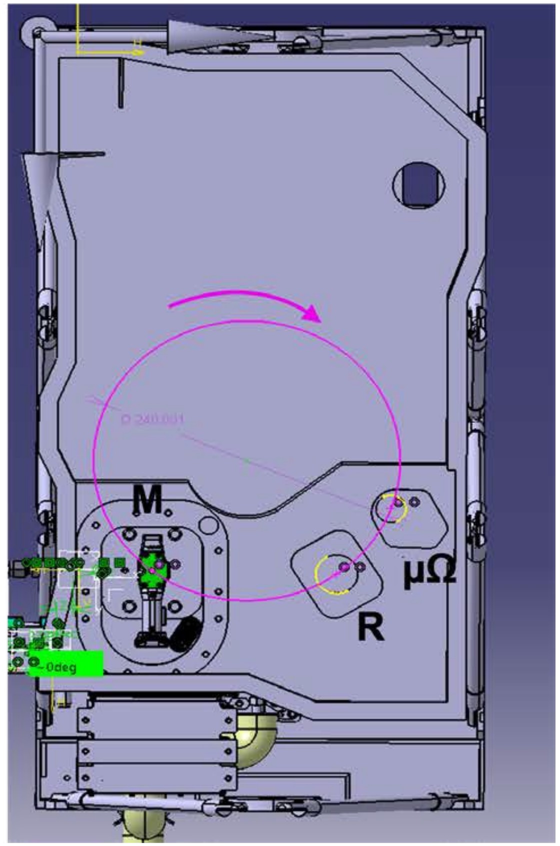


Misiones Futuras: ExoMars - Rosalind Franklin

Muestra de calibrado del RLS (Raman Laser Spectrometer)

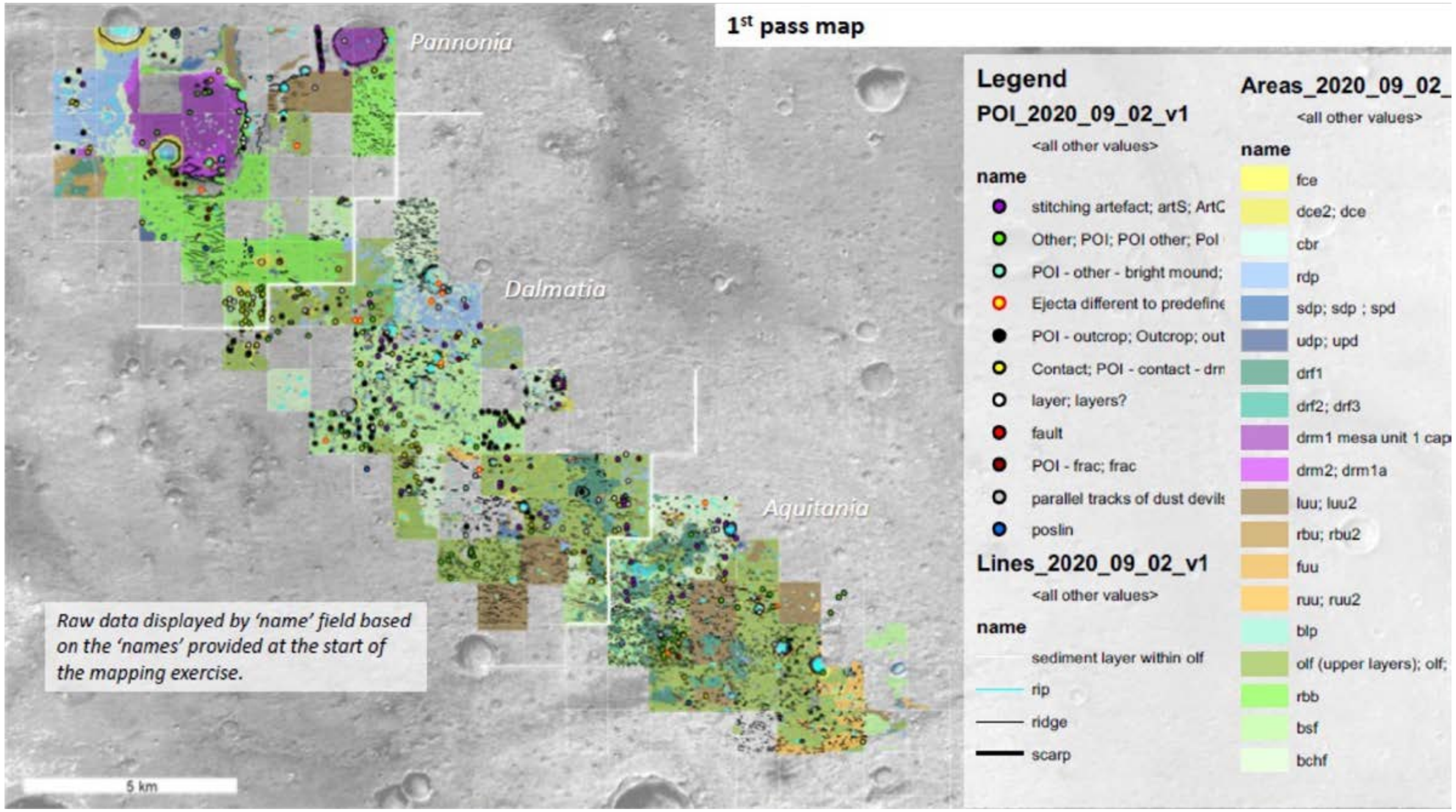






Misiones Futuras: ExoMars - Rosalind Franklin

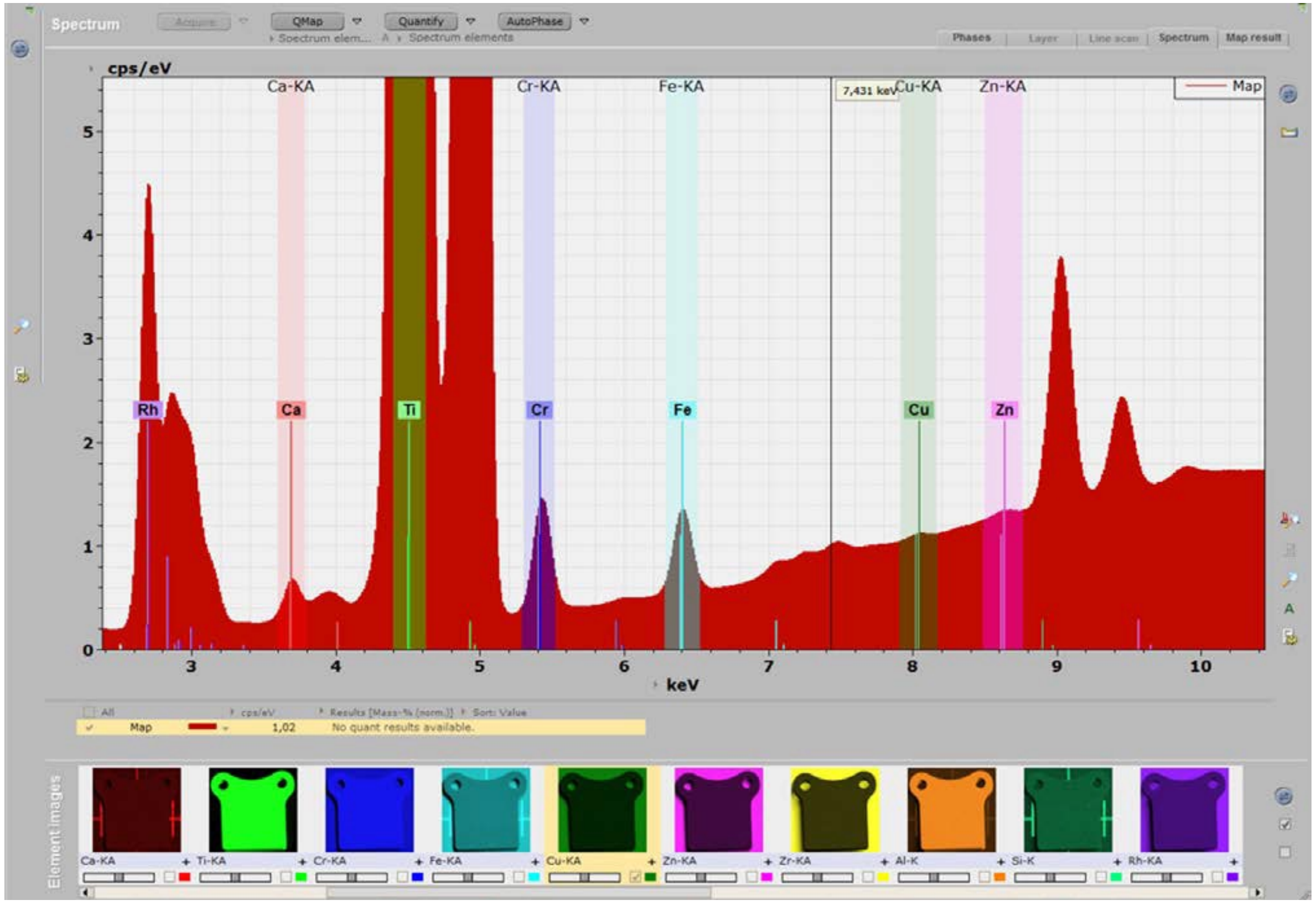
Mapa Geológico de Oxia Planum



Misiones Futuras: Otras Misiones

Desarrollo tecnológico tras la construcción de las muestras de calibrado

El avance se consigue con desarrollos conjuntos entre universidad, centros tecnológicos y empresas.



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- SENER
- CTA
- Renishaw
- Bruker


Eskerrik asko zuen arretagatik
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