SMMP Research Roundup – April 2021

For member publications from Oct 2019 – March 2021

Both peer-reviewed and general publications are listed by category, as designated by the submitting author. Up to 200 words of each abstract has been included only if the submitting author included the abstract in the form.

Categories:

ANALYTICAL METHODS

Peer-reviewed

Lymer, Elizabeth A., Michael G. Daly, Kimberly T. Tait, Veronica E. Di cecco, and Emmanuel A. Lalla. "UV Laser-induced Fluorescence Spectroscopy as a Non-destructive Technique for Mineral and Organic Detection in Carbonaceous Chondrites." Meteoritics & Planetary Science 55, no. 10 (October 2020): 2287–2300. https://doi.org/10.1111/maps.13580.

> Here, we discuss the merits of non-destructive UV laser-induced fluorescence spectroscopy (LIF) as a flight or laboratory instrument to analyze organic and mineral material in samples on or returned from carbon-rich asteroids such as (101955) Bennu by NASA's OSIRIS-REx mission. LIF is a unique instrument that is non-destructive while acquiring data, and allows for no sample preparation, crushing, or cutting. This method provides spectral data indicative of specific minerals and organics in less time than Raman spectroscopy, and can be set up to produce 2-D raster images of areas of interest. Furthermore, if an LIF system is set up with a gated CCD camera, time-resolved fluorescence spectroscopy can be performed, providing a unique identification tool for organic and mineral contents using fluorescence decay over several nanoseconds. This technique was used to analyze millimeter-sized chondrules and calcium-aluminum-rich inclusions on four carbonaceous chondrite samples provided by the Royal Ontario Museum: Murchison (CM2), Allende (CV3), NWA 11554 (CV3), and NWA 12796 (CK3). The LIF 2-D maps, point spectra, and time-resolved fluorescence data and mineral identifications using LIF were compared to that of well-known techniques such as Raman spectroscopy and SEM/EDS.

COLLECTIONS MANAGEMENT

Peer-reviewed

Franza, Annarita, and Giovanni Pratesi. "Meteorites as a Scientific Heritage." Conservar Património, November 4, 2020. https://doi.org/10.14568/cp2020018.

> This paper investigates the importance of meteorites as a scientific heritage. While the significance of meteorites as natural heritage is relatively easy to establish, the implication of their meaning as scientific

heritage may be more difficult to define. With this aim in mind, in this paper, we present the catalogue standards for meteorite specimens, preserved either in natural history museums or in private collections, proposed by the Italian Istituto Centrale per il Catalogo e la Documentazione – ICCD (Central Institute for Catalogue and Documentation). This work outlines the structure of the catalogue card that describes the meteorite specimen along with other information related to the sample (e.g., archival documentation on collectors and traders, museum catalogues and inventories, general bibliography). This paper concludes discussing the cataloguing, according to ICCD standards, of two Renazzo meteorite specimens, which fell in the eponymous Italian village in 1824 and are now preserved at the Natural History Museum of the University of Firenze.

Pratesi, Giovanni, Annarita Franza, Elena Lascialfari, and Luciana Fantoni. "Diamonds Are a Museum's Best Friends. Historical-Scientific Study of the Diamond Collection at the Natural History Museum of the University of Firenze." Museologia Scientifica 14 (2020): 50–56.

This paper focused on the historical-scientific study of the diamond specimens preserved at the Mineralogical and Lithological Section of the Natural History Museum of the University of Firenze, analyzing the theoretical trajectories that the specimens have traced since their entry into the museum, along with the relationships with the people who have recovered and studied them in the past. The study therefore "unpacked" this diamond collection, considering the specimens included in it as material, scientific and social representations. This approach is made possible through the analysis of the role attributed to the diamond samples by the Florentine Natural History Museum over the centuries, along with the investigation of their function in contemporary scientific speculation, thanks to the study of the connections they continue to have with curators, scholars and visitors.

Pratesi, Giovanni, and Annarita Franza. "Mineralogical, Petrological and Planetological Heritage. The (Italian) Story so Far." Rendiconti Lincei. Scienze Fisiche e Naturali 32, no. 1 (March 2021): 95–116. https://doi.org/10.1007/s12210-020-00970-2.

This paper investigates the importance of meteorites as a scientific heritage. While the significance of meteorites as natural heritage is relatively easy to establish, the implication of their meaning as scientific heritage may be more difficult to define. With this aim in mind, in this paper, we present the catalogue standards for meteorite specimens, preserved either in natural history museums or in private collections, proposed by the Italian Istituto Centrale per il Catalogo e la Documentazione – ICCD (Central Institute for Catalogue and Documentation). This work outlines the structure of the catalogue card that describes the meteorite specimen along with other information related to the sample (e.g., archival documentation on collectors and traders, museum catalogues and inventories, general bibliography). This paper concludes discussing the cataloguing, according to ICCD standards, of two Renazzo meteorite specimens, which fell in the eponymous Italian village in 1824 and are now preserved at the Natural History Museum of the University of Firenze.

General publications

Kjellman, Heide & Heide. "On the historical crystal model sets in the Mineral Collections of Abraham Gottlob Werner of the TU Bergakademie Freiberg." Print, Freiberger Forschungshefte D 250. 2020. https://www.researchgate.net/profile/Johan-Kjellman-2

This article is an overview and assessment of various old crystal model collections, preserved in Bergakademie Freiberg and associated to Abraham Gottlob Werner (1749-1817) who was active there from 1769 up until his death. Such early model sets are often exquisitely made and examples of skilful craftsmanship but could be

used for studies of material culture, scientific exchange and science evolution. In the illustrated article different aspects of each part of this important suite of crystal model sets are described and discussed: The earliest models, c. 1770-80, represent the thinking of Linnaeus (1768) and Werner (1774); Successively larger crystal model sets by makers Löscher and Schmidt in Freiberg, as well as graphical representations of diverse "crystal systems", represent the "developed" crystallographic thinking of Werner (c. 1785-1815); Brass, wood, and porcelain models made by pioneering French model makers and illustrating the crystallographic ideas of Romé de l'Isle (1783) and Haüy (1784 and 1801) arrived in Freiberg c. 1790-1805. The youngest collection, comprising gypsum models ordered after Mohs (1822), was made by Zippe in Prague around 1820. The article can serve as a guide for museum workers to identify crystal model suites in their own collections.

MINERALOGY

Peer-reviewed

Boulliard, Jean-Claude, Jérôme Aléon, and Eloïse Gaillou. "On the Anomalous Shapes of Native Copper Crystals from the Michigan Copper Country." *European Journal of Mineralogy* 33, no. 1 (January 29, 2021): 9–21. https://doi.org/10.5194/ejm-33-9-2021.

Falster, Alexander U., William B. Simmons, Karen L. Webber, Donald A. Dallaire, James W. Nizamoff, and Raymond A. Sprague. "The Emmons Pegmatite, Greenwood, Oxford County, Maine." Rocks & Minerals 94, no. 6 (November 2, 2019): 498–519. https://doi.org/10.1080/00357529.2019.1641021.

Post, Jeffrey E., David A. McKeown, and Peter J. Heaney. "Raman Spectroscopy Study of Manganese Oxides: Layer Structures." American Mineralogist 106, no. 3 (March 1, 2021): 351–66. https://doi.org/10.2138/am-2021-7666.

———. "Raman Spectroscopy Study of Manganese Oxides: Tunnel Structures." American Mineralogist 105, no. 8 (August 1, 2020): 1175–90. https://doi.org/10.2138/am-2020-7390.

Tacker, R. Chris. "A Review of 'Pyrite Disease' for Paleontologists, with Potential Focused Interventions." Palaeontologia Electronica, 2020. https://doi.org/10.26879/1044.

A literature review of the chemical reactions involved in pyrite oxidation/hydration ("pyrite disease") in geological or fossil collections gives direction to a suite of focused interventions. Reactions on the pyrite surface lie at the heart of the chemical process, accompanied by the movement of electrons on and through the pyrite semiconductor. Control of these electrons ultimately may be futile, but examination of the reactions at the atomic level leads to new possibilities for treatment, and identifies why some treatments are ineffective. This review also identifies gaps in our understanding of the oxidation and hydration reactions.

Peer-reviewed - New minerals (abstracts omitted)

Bindi, Luca, and John A. Jaszczak. "Richardsite, Zn2CuGaS4, A New Gallium-Essential Member of the Stannite Group from the Gem Mines near Merelani, Tanzania." Minerals 10, no. 5 (May 2020): 467. https://doi.org/10.3390/min10050467.

Kampf, Anthony R., Aaron J. Celestian, and Barbara P. Nash. "Jasonsmithite, a New Phosphate Mineral with a Complex Microporous Framework, from the Foote Mine, North Carolina, U.S.A." American Mineralogist 106, no. 2 (February 1, 2021): 174–79. https://doi.org/10.2138/am-2020-7582.

Kampf, Anthony R., Mark A. Cooper, John M. Hughes, Barbara P. Nash, Frank C. Hawthorne, and Joe Marty. "Caseyite, a New Mineral Containing a Variant of the Flat-Al13 Polyoxometalate Cation." American Mineralogist 105, no. 1 (January 1, 2020): 123–31. https://doi.org/10.2138/am-2020-7181.

Kampf, Anthony R., Barbara P. Nash, Jakub Plášil, Jason B. Smith, and Mark N. Feinglos. "Niasite and johanngeorgenstadtite, $Ni^{2+}_{4.5}(AsO_4)_3$ dimorphs from Johanngeorgenstadt, Germany." European Journal of Mineralogy 32, no. 3 (June 30, 2020): 373–85. https://doi.org/10.5194/ejm-32-373-2020.

Olds, Travis A., Anthony R. Kampf, Fabrice Dal Bo, Peter C. Burns, Xiaofeng Guo, and John S. McCloy. "Jeankempite, Ca 5 (AsO 4) 2 (AsO 3 OH) 2 (H 2 O) 7 , a New Arsenate Mineral from the Mohawk Mine, Keweenaw County, Michigan, USA." Mineralogical Magazine 84, no. 6 (December 2020): 959–69. https://doi.org/10.1180/mgm.2020.92.

Plášil, Jakub, Anthony R. Kampf, Nicolas Meisser, Cédric Lheur, Thierry Brunsperger, and Radek Škoda. "Smamite, Ca2Sb(OH)4[H(AsO4)2] ·6H2O, a New Mineral and a Possible Sink for Sb during Weathering of Fahlore." American Mineralogist 105, no. 4 (April 1, 2020): 555–60. https://doi.org/10.2138/am-2020-7133.

General publications

Jaszczak, John A. "Who's Who in Mineral Names: R. Peter Richards (b. 1943)." Rocks & Minerals 95, no. 6 (November 1, 2020): 565–66. https://doi.org/10.1080/00357529.2020.1791631.

Short biography of Dr. R. Peter Richards and the new mineral richardsite that was named in his honor.

Werner Radl, John I. Koivula, and John A. Jaszczak. "Merelaniite in Gem Diopside from Merelani, Tanzania." Gems & Gemology 55, no. 3 (Fall 2019). https://www.gia.edu/gems-gemology/fall-2019-microworld-merelaniite-in-gem-diopside

Whiskers of merelaniite, including some with disk-like overgrowths, occur as inclusions in gem diopside crystals from the mines near Merelani, Tanzania.

GEOLOGY/EARTH SCIENCE

General publications

Moclock, Leslie, and Jacob Selander. Rocks, Minerals & Geology of the Pacific Northwest. Portland, Oregon: Timber Press, 2021. https://www.workman.com/products/rocks-minerals-and-geology-of-the-pacific-northwest.

A field guide to the minerals, rocks, and geology of Oregon and Washington states (USA) emphasizing object/feature identification and interpretation skills as well as regional geologic highlights and histories.

PLANETARY GEOLOGY

Peer-reviewed

Černok, Ana, Mahesh Anand, Xuchao Zhao, James R. Darling, Lee F. White, Alice Stephant, Joseph Dunlop, Kimberly T. Tait, and Ian A. Franchi. "Preservation of Primordial Signatures of Water in Highly-Shocked Ancient Lunar Rocks." Earth and Planetary Science Letters 544 (August 2020): 116364. https://doi.org/10.1016/j.epsl.2020.116364.

Spurred by the discovery of water in lunar volcanic glasses about a decade ago, the accessory mineral apatite became the primary target to investigate the abundance and source of lunar water. This is due to its ability to contain significant amounts of OH in its structure, along with the widespread presence of apatite in lunar rocks. There is a general understanding that crustal cumulate rocks of the lunar magnesian (Mg) suite are better candidates for recording the original isotopic compositions of volatile elements in their parental melts compared to eruptive rocks, such as mare basalts. Consequently, water-bearing minerals in Mg-suite rocks are thought to be ideal candidates for discerning the primary hydrogen isotopic composition of water in the lunar interior. Mg-suite rocks and most other Apollo samples that were collected at the lunar surface display variable degrees of shock-deformation. In this study, we have investigated seven Apollo 17 Mg-suite samples that include troctolite, gabbro and norite lithologies, in order to understand if shock processes affected the water abundances and/or H isotopic composition of apatite. [abstract truncated]

Gardiol, D, D Barghini, A Buzzoni, A Carbognani, M Di Carlo, M Di Martino, C Knapic, et al. "Cavezzo, the First Italian Meteorite Recovered by the PRISMA Fireball Network. Orbit, Trajectory, and Strewn-Field." Monthly Notices of the Royal Astronomical Society 501, no. 1 (December 30, 2020): 1215–27. https://doi.org/10.1093/mnras/staa3646.

Two meteorite pieces have been recovered in Italy, near the town of Cavezzo (Modena), on 2020 January 4th. The associated fireball was observed on the evening of New Year's Day 2020 by eight all-sky cameras of the PRISMA fireball network, a partner of FRIPON. The computed trajectory had an inclination angle of approximately 68° and a velocity at infinity of 12.8 km s−1. Together with the relatively low terminal height, estimated as 21.5 km, those values were indicating the significant possibility of a meteorite dropping event, as additionally confirmed by the non-zero residual total mass. The strewn-field was computed taking into account the presence of two bright light flashes, revealing that the meteoroid had been very likely subject to fragmentation. Three days after the event, two samples, weighing 3.1 and 52.2 g, were collected as a result of a dedicated field search and thanks to the involvement of the local people. The two pieces were immediately recognized as freshly fallen fragments of meteorite. The computed orbital elements, compared with the ones

of known Near-Earth Asteroids from the NEODyS database, are compatible with one asteroid only; 2013 VC10. The estimated original mass of the meteoroid, 3.5 kg, and size, approximately 13 cm, is so far the smallest among the current 35 cases in which meteorites were recovered from precise strewn-field computation thanks to observational data. This result demonstrates the effectiveness of accurate processing of fireball network data even on challenging events generated by small size meteoroids.

Pratesi, Giovanni, Stefano Caporali, Richard C. Greenwood, Vanni Moggi Cecchi, and Ian A. Franchi. "A Detailed Mineralogical, Petrographic, and Geochemical Study of the Highly Reduced Chondrite, Acfer 370." Meteoritics & Planetary Science 54, no. 12 (December 2019): 2996–3017. https://doi.org/10.1111/maps.13409.

Among the many ungrouped meteorites, Acfer 370, NWA 7135, and El Medano 301—probably along with the chondritic inclusion in Cumberland Falls and ALHA 78113— represent a homogeneous grouplet of strongly reduced forsterite-rich chondrites characterized by common textural, chemical, mineralogical, and isotopic features. All of these meteorites are much more reduced than OCs, with a low iron content in olivine and low-Ca pyroxene. In particular, Acfer 370 is a type 4 chondrite that has olivine and low-Ca pyroxene compositional ranges of Fa 5.2–5.8 and Fs 9.4–33.4, respectively. The dominant phase is low-Ca pyroxene (36.3 vol%), followed by Fe-Ni metal (16.3 vol%) and olivine (15.5 vol%); nevertheless, considering the Fe-oxyhydroxide (due to terrestrial weathering), the original metal content was around 29.6 vol%. Finally, the mean oxygen isotopic composition D17O = +0.68& along with the occurrence of a silica phase, troilite, Ni-rich phosphides, chromite, and oldhamite confirms that these ungrouped meteorites have been affected by strong reduction and are different from any other group recognized so far.

White, L. F., A. Černok, J. R. Darling, M. J. Whitehouse, K. H. Joy, C. Cayron, J. Dunlop, K. T. Tait, and M. Anand. "Evidence of Extensive Lunar Crust Formation in Impact Melt Sheets 4,330 Myr Ago." Nature Astronomy 4, no. 10 (October 2020): 974–78. https://doi.org/10.1038/s41550-020-1092-5.

Accurately constraining the formation and evolution of the lunar magnesian suite is key to understanding the earliest periods of magmatic crustal building that followed accretion and primordial differentiation of the Moon. However, the origin and evolution of these unique rocks is highly debated. Here, we report on the microstructural characterization of a large (~250-μm) baddeleyite (monoclinic-ZrO2) grain in Apollo troctolite 76535 that preserves quantifiable crystallographic relationships indicative of reversion from a precursor cubic-ZrO2 phase. This observation places important constraints on the formation temperature of the grain (>2,300 °C), which endogenic processes alone fail to reconcile. We conclude that the troctolite crystallized directly from a large, differentiated impact melt sheet 4,328 ± 8 Myr ago. These results suggest that impact bombardment would have played a critical role in the evolution of the earliest planetary crusts.

White, Lee F., Kimberly T. Tait, Sandra L. Kamo, Desmond E. Moser, and James R. Darling. "Highly Accurate Dating of Micrometre-Scale Baddeleyite Domains through Combined Focused Ion Beam Extraction and U–Pb Thermal Ionization Mass Spectrometry (FIB-TIMS)." Geochronology 2, no. 2 (July 7, 2020): 177–86. https://doi.org/10.5194/gchron-2-177-2020.

Baddeleyite is a powerful chronometer of mafic magmatic and meteorite impact processes. Precise and accurate U–Pb ages can be determined from single grains by isotope dilution thermal ionization mass spectrometry (ID-TIMS), but this requires disaggregation of the host rock for grain isolation and dissolution. As a result, the technique is rarely applied to precious samples with limited availability (such as lunar, Martian, and asteroidal meteorites and returned samples) or samples containing small baddeleyite grains that cannot readily be isolated by conventional mineral separation techniques. Here, we use focused ion beam (FIB) techniques, utilizing both Xe+ plasma and Ga+ ion sources, to liberate baddeleyite subdomains directly,

allowing their extraction for ID-TIMS dating. We have analysed the U–Pb isotope systematics of domains ranging between 200 and 10 μm in length and from 5 to ≤0.1 μg in mass. In total, six domains of Phalaborwa baddeleyite extracted using a Xe+ plasma FIB (pFIB) yield a weighted mean 207Pb/206Pb age of 2060.1±2.5 Ma (0.12 %; all uncertainties 2σ), within uncertainty of reference values. The smallest extracted domain (ca. 10×15×10 μm) yields an internal 207Pb/206Pb age uncertainty of ±0.37 %. [abstract truncated]

White, Lee F., Kimberly T. Tait, Brian Langelier, Elizabeth A. Lymer, Ana Černok, Tanya V. Kizovski, Chi Ma, Oliver Tschauner, and Richard I. Nicklin. "Evidence for Sodium-Rich Alkaline Water in the Tagish Lake Parent Body and Implications for Amino Acid Synthesis and Racemization." Proceedings of the National Academy of Sciences 117, no. 21 (May 26, 2020): 11217–19. https://doi.org/10.1073/pnas.2003276117.

Understanding the timing and mechanisms of amino acid synthesis and racemization on asteroidal parent bodies is key to demonstrating how amino acids evolved to be mostly left-handed in living organisms on Earth. It has been postulated that racemization can occur rapidly dependent on several factors, including the pH of the aqueous solution. Here, we conduct nanoscale geochemical analysis of a framboidal magnetite grain within the Tagish Lake carbonaceous chondrite to demonstrate that the interlocking crystal arrangement formed within a sodium-rich, alkaline fluid environment. Notably, we report on the discovery of Na-enriched subgrain boundaries and nanometer-scale Ca and Mg layers surrounding individual framboids. These interstitial coatings would yield a surface charge state of zero in more-alkaline fluids and prevent assimilation of the individual framboids into a single grain. This basic solution would support rapid synthesis and racemization rates on the order of years, suggesting that the low abundances of amino acids in Tagish Lake cannot be ascribed to fluid chemistry.

General publications

Cecchi, Vanni Moggi, Manuela Rossi, Maria Rosaria Ghiara, Giovanni Pratesi, and Annarita Franza. "An Unrevealed Treasure: A New Italian Meteorite from the Royal Mineralogical Museum of Naples." Geology Today 35, no. 6 (November 2019): 212–16. https://doi.org/10.1111/gto.12293.

Naturalistic and geo-mineralogical museum collections are one of the most relevant sources for research on meteorites the world over. Here, we present the description of a new Italian meteorite that has been recently discovered at the Royal Mineralogical Museum of Naples in Italy.

PALEONTOLOGY

Peer-reviewed

Young, Graham A., and James W. Hagadorn. "Evolving Preservation and Facies Distribution of Fossil Jellyfish: A Slowly Closing Taphonomic Window." Bollettino Della Società Paleontologica Italiana 59, no. 3 (2020): 185–203. https://doi.org/10.4435/BSPI.2020.22.

Sundberg, F.A., K.E. Karlstrom, G. Geyer, J.R. Foster, J.W. Hagadorn, M.T. Mohr, M.D. Schmitz, C.M. Dehler, and L.J. Crossey. "Asynchronous Trilobite Extinctions at the Early to Middle Cambrian Transition." Geology 48, no. 5 (May 1, 2020): 441–45. https://doi.org/10.1130/G46913.1.

OTHER TOPICS

Peer-reviewed

Clause, Adam G., Aaron J. Celestian, and Gregory B. Pauly. "Plastic Ingestion by Freshwater Turtles: A Review and Call to Action." Scientific Reports 11, no. 1 (December 2021): 5672. https://doi.org/10.1038/s41598-021-84846-x.

Plastic pollution, and especially plastic ingestion by animals, is a serious global issue. This problem is well documented in marine systems, but it is relatively understudied in freshwater systems. For turtles, it is unknown how plastic ingestion compares between marine and non-marine species. We review the relevant turtle dietary literature, and find that plastic ingestion is reported for all 7 marine turtle species, but only 5 of 352 non-marine turtle species. In the last 10 years, despite marine turtles representing just 2% of all turtle species, almost 50% of relevant turtle dietary studies involved only marine turtles. These results suggest that the potential threat of plastic ingestion is poorly studied in non-marine turtles. We also examine plastic ingestion frequency in a freshwater turtle population, finding that 7.7% of 65 turtles had ingested plastic. However, plastic-resembling organic material would have inflated our frequency results up to 40% higher were it not for verification using Raman spectroscopy. Additionally, we showcase how non-native turtles can be used as a proxy for understanding the potential for plastic ingestion by co-occurring native turtles of conservation concern. We conclude with recommendations for how scientists studying non-marine turtles can improve the implementation, quality, and discoverability of plastic ingestion research.