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SURFICIAL PROCESSES-GEOMORPHOLOGY, CHEMICAL WEATHERING, EXPOSURE AGE DATING, AND PERMAFROST DYNAMICS

Berry Lyons
Mauro Guglielmin, Melisa Diaz

ABSTRACTS SUBMITTED TO THE (CANCELLED) SCAR 2020 OSC IN HOBART

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The role of microparticles of organic carbon in degradation of ice cover of polar regions of the Earths and in the process of soil-like bodies formation

Evgeny Abakumov[1], Viacheslav Polyakov[1]
[1]*Saint-petersbug State University, Saint-petersburg, Russian Federation*

Rapid glaciers retreatment in polar and mountain regions of the Earth is resulted from not only direct effect of the climate changes, but, at the same time, with the global transfer of micropartciles and their accumulation on the surface of ice. An accumulation of these microparticles on the glaciers surface result in changing of albedo values and ice-sheets degradation. The cryoconites play a specific role in glaciers degradation, these formations are presented by specific orgainc soil-like bodies. They present self-deppening dark colored formations and aggregations in the surface part of the glacier. Incide the ice layer, they become aggregates and form space-developed web of organo-menral material, which finally result in intensification of deglaciation. In this context complex investigation of this process with use if numerous instrumental and molecular methods has been conducted. Data obtained with the use two-dimensional NMR spectrometry indicate that the stabilization rate of organic matter of cryoconite is higher than is soils of adjacent terrestrial ecosystems. Data on chemical composition of cryoconites are discussed as well new information about the component composition of polycyclic aromatic compounds. Microbial community of the cryoconites on the base of metagenomic analyzes is characterized as well.

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Ornitogenic soils of Livingstone and King-George Islands, Western Antarctica

Evgeny Abakumov[2], Miglena Zhiyanski[2], Rossitsa Yaneva[2], Maria Sokolovska[2], Alexey Lupachev[3]
[1]Saint-Petersbug State University, Saint-Petersburg, Russian Federation, [2]Institute of Forestry, Sofia, Bulgaria, [3]Institute of Physico-chemical and biological problems of soil science, Pushino na Oke, Russia

The present study is devoted to investigation of the role of the bird in soil formation and initiation of biogenic-abiogenic interactions in the terrestrial ecosystems of Livingston and King-George Islands. The ornitogenic soils of the investigated areas could be divided into three categories: 1 soils of the penguin rockeries with slightly decomposed guano (classic ornitogenic soils), 2 soils, formed under transported materials of plants, used by birds for nest building and remnants of food (skua rocks), soils under birds transported remnants of mollusks and fish (petrel rocks). Also, the postornitogenic successions are well pronounced in the terrestrial environments of the territory investigated. The first stage of this succession is presented by leaching of guano components and migration of leaching products in adjacent landscapes and colonization of postornitogenic plots by the algae – Prasiola crispa. The next stage is represents colonization of soils by vascular plants Deschampsia Antarctica and Colobanthus quitensis. This is very important in terms of soil formation cause results in formation of developed humus horizon with evident crumb structure and high humification rate of organic matter. According the soil morphology and spatial distribution, the territory investigated could be classified as maritime tundra with the dominance of Cryosols Ornitic Hyperskeletic. Data of 13-NMR spectrocscopy of organic matter of various ornitogenic soil showed the higher degree of stabilization rate of humic acids, formed under vascular plants, than in those, sampled under fresh guano.
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Evolution of the Eastern Antarctic Ice Sheet in Queen Maud Land since the Late Miocene

Naki Akçar[1,2], Serdar Yeşilyurt[1,3], Vural Yavuz[4], Christof Vockenhuber[5], Marcus Christl[5], Kristina Hippe[5], Yusuke Suganuma[6,7], Hideki Miura[6,7], Burcu Özsoy[2,8]

[1]Institute of Geological Sciences, University of Bern, Bern, Switzerland, [2]Polar Research Institute, TÜBITAK Marmara Research Center, Istanbul, Turkey, [3]Department of Geography, Ankara University, Ankara, Turkey, [4]Faculty of Engineering, Turkish-German University, Istanbul, Turkey, [5]Laboratory of Ion Beam Physics, ETH Zurich, , Zurich, Switzerland, [6]National Institute of Polar Research, Tokyo, Japan, [7]Department of Polar Science, The Graduate University for Advanced Studies, Tokyo, Japan, [8]Maritime Faculty, Istanbul Technical University , Istanbul, Turkey

The spatial distribution of the dramatic surface lowering of East Antarctic Ice Sheet (EAIS) in the Queen Maud Land for the last million years is not yet fully explored. Today, Sør Rondane Mountains acts as a barrier to the EAIS. Around 1000 m difference in altitude of the ice surface to the south and north of the mountain chain shows this barrier and today's drainage pattern. In this study, we used suite of cosmogenic nuclides (10Be, 14C, 26Al and 36Cl) in 38 rock surface samples to decipher the timing, magnitude and frequency of the surface lowering history and change in drainage pattern of the EAIS in the western Sør Rondane Mountains. Our results show that the surface of the EAIS was at least 400 meters higher than today from the Late Miocene until the Pliocene Warming and that the major drainage was towards northeast over the mountain range. At the beginning of Pliocene, ice surface started to sublimate, and the south-north drainage was broken by prior to ca. 1.3 Ma. This caused the ice drainage to be channelized into either few main valleys or around the mountain range. Afterwards, the glaciation continued until around 130 ka, when a dramatic decrease in the ice surface elevation occurred in the ice lowlands to the north of the mountain chain. However, the ice plateau to the south seems not to be affected by the dramatic changes occurred on the northern side of the mountain range.

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Permafrost and active layer temperature regimes and their geographical controls (Barton Peninsula, King George Island, Antarctica)

Joana Baptista[1], Gonçalo Vieira[1], Pedro Ferreira[2], Daniel Vonder Mühll[3], António Correia[4], Soon Gyu Hong[5]
[1]CEG/IGOT, University Of Lisbon, Lisbon, Portugal, [2]LNEG, Lisbon, Portugal, [3]ETH, Zurich, Switzerland, [4]University of Évora, Évora, Portugal, [5]Korea Polar Research Institute, Incheon, South Korea

The South Shetlands are located off the northern tip of the Antarctic Peninsula close to the climatic limit of permafrost. The climate is cold oceanic with mean annual air temperatures of ci. -2°C at sea-level. Boreholes drilled in bedrock show permafrost temperatures of -1.8 ºC at mountain sites (270 m) and the absence of permafrost close to sea-level.
Until the Antarctic season of 2018-19, the deepest borehole in King George Island was at low elevation Bellingshausen station in Fildes Peninsula (8 m deep) with temperatures of -0.35 ºC. Data on permafrost temperatures, in boreholes deeper than 10 m was fully lacking in King George Island, and hence a new borehole integrated in the PERMANTAR network and in GTN-P was drilled in 2019 in Barton Peninsula. The King Sejong Station Borehole was drilled in massive andesite at 128 m asl, reaching a depth of 13.2 m. Temperature data is recorded hourly using a datalogger with 15 temperature sensors. 20 ibuttons were installed in different terrain settings to monitor the spatial variability of ground surface temperature.
We present the analysis of the ground temperature regimes for the period 2019-20 and provide a first insight on the permafrost conditions in Barton Peninsula, with -1,5°C at 13 m depth. Snow cover is examined using Sentinel-1 and ground temperature and freezing and thawing indexes are analyzed using a GIS in order to assess the geographical controlling factors. The first data on ground temperatures associated to the warm summer of 2019-20 is discussed.

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Million-Year-Old Ice Found Near Surface; Ong Valley, Transantarctic Mountains, Antarctica

Marie Bergelin[1], Jaakko Putkonen[1], Greg Balco[2], Dan Morgan[3], Ronald K. Matheney[1]
[1]University of North Dakota, Grand Forks, United States, [2]Berkeley Geochronology Center, Berkeley, United States, [3]Vanderbilt University, Nashville , United States

We have discovered a massive buried ice mass in Ong Valley, Transantarctic Mountains, Antarctica, from which we collected two 10-meter ice cores. This ice mass is buried under a thin layer (< 1 m) of sublimation till and cosmogenic-nuclide measurements from the overlying till have revealed a minimum exposure age of > 1.1 Ma, therefore making this one of the oldest ice bodies found on Earth.

To obtain additional constraints on the age, origin, and sublimation rate of the ice, we measured concentrations of the cosmic-ray produced nuclides ^{10}Be, ^{26}Al, and ^{21}Ne in englacial sediment in one core. These nuclides are produced by cosmic-ray interactions with minerals near the Earth's surface. As the production rate decreases rapidly with depth below the Earth's surface, nuclide concentrations can yield information about the age of the ice, and the rate at which the till is forming due to ice sublimation, and surface erosion rates. In addition to the cosmogenic nuclide measurement, we have analyzed deuterium and oxygen isotopes throughout the ice core.

Large downcore variations in both water isotopes and cosmogenic nuclide concentrations suggests that the last few meters of the ice core may belong to a separate, older ice body that has previously been exposed at the surface and most likely buried during a later glacial advancement into Ong Valley. Lateral moraines and till located further up valley suggest that this deeper ice mass may be > 2.6 Ma old.

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Deglaciation of large East Antarctic glacial basins that are grounded below sea level. A study of the Denman Glacial Basin

Marcello Blaxell[1], David Fink[2], Toshiyuki Fujioka[6], Klaus Wilcken[2], Alexandru Codilean[5], Steven Phipps[3], David Small[4], Matthew Jeromson[1], Simon Foster[1], Duanne White[1]

[1]Faculty of Science and Technology, University Of Canberra, Canberra, Australia, [2]Australian Nuclear Science and Technology Organisation (ANSTO), Lucas Heights, Australia, [3]Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Australia, [4]Department of Geography, Durham University, Durham, United Kingdom, [5]Faculty of Science, Medicine and Health, University of Wollongong, Wollongong, Australia, [6]Centro de Investigación sobre la Evolución Humana (CENIEH), Inicio Ciencia Infraestructuras Científicas y Técnicas Singulares (ICTS), Burgos, Spain

Parts of the East Antarctic Ice Sheet (EAIS) such as the Aurora and Wilkes subglacial basin are grounded mostly below sea level. Here, the ice is susceptible to Marine Ice Sheet Instability that may rapidly destabilize the subaerial ice mass. Modern measurements of ice drainages in this region are accelerating and thinning at high rates, but we lack the geologic records of past ice sheet behaviour in this area needed to provide context for the modern rates of change, and calibrate numerical ice sheet models used to simulate future ice sheet response. In this study, we apply cosmogenic ^{10}Be exposure dating of glacial erratics, to investigate one of the major drainages of the Aurora Basin, the Denman Glacier to determine its past behaviour.

Preliminary data suggest the retreat and stabilisation of the Denman Glacier was completed relatively early (~11 ka BP), suggesting a rapid response to climate and sea level changes following the Last Glacial Maximum (LGM). This contrasts to previously studied regions that are grounded mostly above sea level including Dronning Maud Land, Enderby Land and Mac Robertson Land, where ice sheet retreat and thinning continued for at least another 2-7 ka, stabilising as late at 5 ka BP.

Here we present a more complete picture of the deglaciation timing of Denman Glacier since the LGM and assess the vulnerability of large glacial basins that are grounded largely below sea level to a warming climate.

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Geochemical and Sedimentological Characteristics of Modern Beach Sediments from Southern Part of Coastal Area at Hannah Point, Byers Peninsula, Livingston Island-South Shetland Islands, Antarctica.

Mehmet Nuri Bodur[1]
[1]*University, Hakkari, Turkey*

This study presents to research characteristics of modern beach sediments from Southern part of Hannah Point located in between coordinates 62°39‘14“ S and 60°36‘39“ W, Byers Peninsula at Livingston Island.

The purpose of this study is to investigate geodynamics of sediments with their provenance such as; glaciogenic, lithogenic , volcanogenic, cosmogenic, ornithogenic and also anthropogenic at Hannah Point cove.

In order to realization of this research with the integrative approach will be applied to study sedimentological and geochemical characteristics of sediments with their constituents such as; minerals, major and minor elements, carbonates and also organic carbon contents.

So, the fourteen samples from studied area where consist of loosely admixtures of large sized gravels, especially sand, silt and clay in variable proportions were collected at each sites located approximately 50 m apart from ice-free area to pioneer investigations during 2018 Antarctica austral summer. These samples were taken with a small hand shovel and kept to analyze at laboratory. Those are already analyzing at the laboratory.

As a result, the preliminary observations with varying gravel sizes on beach marks coastline which is seen that it is strongly affected by changing of tidal levels at southern part of Hannah point cove. This phenomenon tells us that the area is also hopefully under the effect of regionally geodynamics with changing of seasonal conditions in this place. Gravelly (boulder to granules) and sandy character of the beach area is also visible at steep and gentle slopes with exposing area at this side of Hannah Point.

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Chemical weathering and development of clays, sulfates, and chlorides at a transient Dry Valleys brine pond and relevance to Mars

Zachary Burton[1,2], Janice Bishop[2,3], Peter Englert[4], Przemyslaw Dera[4], Christian Koeberl[5], Everett Gibson[6], Jonathan Toner[7]

[1]Stanford University, Stanford, United States, [2]SETI Institute, Mountain View, United States, [3]NASA Ames, Mountain View, United States, [4]University of Hawai'i at Mānoa, Honolulu, United States, [5]University of Vienna and Natural History Museum, Vienna, Austria, [6]NASA Johnson Space Center, Houston, United States, [7]University of Washington, Seattle, United States

The cold and xeric conditions of Antarctica's McMurdo Dry Valleys (MDV) provide an opportunity for investigation of geochemical processes, including chemical weathering, in extreme environments. Furthermore, the cold, dry, ice-free conditions of the MDV present a compelling analogue for the cold, desert environment of Mars. The MDV has been the focus of numerous studies as one of the closest environmental and geological analogues to the martian surface. Central to this comparison is the search for habitable conditions, whereby scarcity of surface water in the MDV can nonetheless lead to occurrence of life. Decisive evidence of past or present habitability remains elusive on Mars, but occurrence of aqueous minerals (e.g., clays, sulfates, chlorides) suggests a complex history of water. We seek to better understand this aqueous history of Mars through study of the development of similar minerals in the MDV. We characterize sediments collected from an intermittent brine pond. These sediments somewhat resemble salt-rich outcrops on Mars, which potentially formed in similar brine systems. Through coordinated geochemistry, spectroscopy, and mineralogy we describe the suite of minerals that have developed in response to the activity of transient liquid water at this site. We observe that surface sediments are characterized by hydrated chlorides, beneath this a chemically active clay layer occurs, and at greater depths, sulfates occur. Development of clays, sulfates, and chlorides provides a direct analogue for formation of clays during activity of liquid water, and of sulfates and chlorides during evaporitic activity, at ancient salt ponds in cold environments on Mars.

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The microbiology of ephemeral meltwater systems of McMurdo Dry Valleys as analogues of Martian gullies

Fabiana Canini[1], József Geml[2], Luigi Paolo D'Acqui[3], Marco Severgnini[4], Clarissa Consolandi[4], Tania Camboni[4], Silvano Onofri[1], Laura Zucconi[1]

[1]University Of Tuscia, Viterbo, Italy, [2]Eszterházy Károly University, Eger, Hungary, [3]National Research Council of Italy , Sesto Fiorentino, Italy, [4]National Research Council of Italy , Segrate, Italy

The surface of the McMurdo Dry Valleys is mainly unconsolidated permafrost. Despite cold and dry conditions, gullies and streams occur during the summer as dark bands on north-facing slopes, from surface top-down melting of snow and ice. They host biological activity that can persist even after water flow has ceased in a cryptobiotic state. These systems may provide important insights into the potential configuration of Mars, in which ephemeral streams and rivers could have originated through processes related to the presence of liquid water more recently than 5 Ma, and could have hosted life forms remained trapped within the gullies. In this optic, soil fungal and bacterial diversity have been characterized via metabarcoding sequencing, in the areas surrounding Lake Fryxell, Lake Hoare and Lake Joyce. We found 11026 and 292 OTUs for bacteria and fungi, respectively, with richness ranging from 1683 to 2935 and from 7 and 122 OTUs, respectively. Main bacterial phyla within Lake Hoare and Lake Joyce communities were Bacteroidetes and Firmicutes, whereas, Lake Fryxell samples showed 28% Cyanobacteria and 3% Deinococcus-Thermus, nearly absent in the other two sites. For fungi we highlighted a dominance of saprotrophic and lichen-forming organisms and a high degree of diversification at phylum level in all samples. Edaphic parameters (soil texture, pH, moisture, C, N, cation exchange capacity and exchangeable cations Na+, K+, Mg2+ and Ca2+) have been tested for correlations with richness and community composition, in order to reveal environmental factors relevant to the terrestrial limits and possible extraterrestrial establishment of life.

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Geoelectrical study of the permafrost and active layer near the Korean Antarctic Station, King George Island, Maritime Antarctica

Antonio Correia[1], Pedro Mendes[1], Kwan Kim[2], Hyeon Ju[2], Soon Hong[2], Joohan Lee[2]
[1]University of Evora, Evora, Portugal, [2]Korean Polar Institute, Incheon, South Korea

Under the framework of the Project Hydrotomo of the Portuguese Polar Program a geoelectrical study was started in January 2018 near the Korean Antarctic Station King Sejong to study the possible influence of permafrost and active layer dynamics in the evolution of mosses and lichens. The study area is located in the Barton Peninsula of King George Island of the South Shetland Islands archipelago. The study area has a rectangular shape of 40 m by 6 m and all the geoelectrical profiles were carried out along the largest side of the area; furthermore, to try to detect any permafrost and active layer thickness time variation, two times a week, during three weeks, three parallel electrical resistivity profiles, spaced by three meters each, were carried out. In each electrical resistivity tomography 40 active electrodes separated by one meter were used in a Wenner configuration. A Lippmann LG High Power equipment was used to measure the apparent electrical resistivities along each profile. The geoelectrical survey allowed detecting the top of the permafrost as well as water zones in the study area. Even preliminary, the obtained results appear to indicate that there is a relationship between high electrical resistivity zones with zones lacking mosses or lichens and vice-versa. Hopefully, the data obtained will allow constructing in the near future three dimension models of the subsurface electrical resistivity distribution.

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Geoelectric survey to study the ground state beneath facilities of the Peruvian Antarctic Station Machu Picchu

Antonio Correia[1], Wai Long Cutipa[2], Pedro Mendes[1]
[1]University of Evora, Evora, Portugal, [2]Instituto Geológico Minero y Metalúrgico, Lima, Peru

A geoelectrical survey using electrical resistivity tomographies was carried out in January 2019 under the facilities of the Peruvian Antarctic Station Machu Picchu. The station is located in the Admiralty Bay of King George Island of the South Shetland Islands archipelago. The main objective of the survey was estimating the depth and the lateral extent of the frozen ground found beneath the main building of the Machu Picchu station during maintenance work performed in the antarctic summer of 2018.
Two rectangular shaped buildings of the Machu Picchu Antarctic Station were chosen to measure the ground electrical resistivity beneath them. In the biggest building the electrical profiles crossed 14 m beneath it along its smallest dimension; in the other (a refuge) the electrical profile crossed 7 m beneath the building, also along its smallest dimension. To carry out the geoelectrical profiles 40 active electrodes were used in a Wenner configuration; 1 m and 2 m distance between adjacent electrodes were used for different profiles.
Preliminary interpretation of the electrical resistivity data indicates that in both buildings there is a small layer of frozen ground which has also been detected by thermometers installed in 2018, as well as by eye inspection after digging a small hole to install new thermometers. However, beneath the frozen ground layer, coinciding with the area of both buildings, a low electrical resistivity layer, about 1 to 2 m thick, with electrical resistivity values as low as 20 Ω.m, was found.

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Geoelectric survey to study the aquifer that provides water the Peruvian Antarctic Station of Machu Picchu

Antonio Correia[1], Wai Long Cutipa[2], Luís Cerpa Cornejo[2], Esteban Falcón[3]
[1]University of Evora, Evora, Portugal, [2]Instituto Geológico Minero y Metalúrgico, Lima, Peru, [3]Instituto Antártico Uruguayo, Montevideo, Uruguay

A geoelectrical survey using electrical resistivity tomographies was started in January 2018 near the Peruvian Antarctic Station of Machu Picchu, located in the Admiralty Bay of King George Island of the South Shetland Islands archipelago. The main objective of the survey was to attempt delineating the geoelectrical structure of the aquifer that provides water for domestic use to the station to estimate the aquifer's lateral and vertical extensions so that a better exploitation plan could be devised; furthermore, since the station is located a few meters from the coast, the work also aimed at identifying areas of possible saline intrusion. The study area (about 90,000 m2) presents glacial, alluvial-glacial, alluvial, alluvial-fluvial, and marine sediments (mostly sandy gravels with some silty gravel layers); in the area where the aquifer is believed to exist several electric resistivity tomographies with lengths that varied from 100 to 300 m long were carried out. Hydrogeologic data were obtained from piezometers located within the area where electrical resistivity tomographies were done; water samples from the piezometers have electrical resistivity values ranging from 25 to 50 Ω.m. Preliminary processing of the geoelectric data obtained along two almost perpendicular directions indicates that several tomographic profiles have crossed the aquifer which appears to be several meters deep; the bedrock is deeper than 60 m. The aquifer formation presents electrical resistivity values that range from about 100 to 400 Ω.m.

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Concentrations and deposition rates of acid soluble metals in Taylor Valley stream deltas – the sediment dynamics in rapidly changing fluvial systems

Brianna Piergallini[1,2], Steven Goldsmith[4], Melisa Diaz[1,2], Kathleen Welch[3], W. Berry Lyons[1,2]
[1]The Ohio State University, Columbus, United States, [2]Byrd Polar and Climate Research Center, Columbus, United States, [3]Institute of Arctic and Alpine Research, Boulder, United States, [4]Villanova University, Villanova, United States

Recent research has documented local rapid landscape change in a number of locales in the McMurdo Dry Valleys where ground subsidence due to melting ground ice, fluvial downcutting, and sediment movement has been measured (Levy et al., 2018). In Taylor Valley, two of the most dynamic fluvial systems are Wales and Commonwealth Streams, where net erosion has been cleared demonstrated. In the summer of 2017, we collected a series of sediment samples from the delta regions of both these streams. The samples were leached with 10% HCl and analyzed for Fe, Ba, Cu, Pb, and Zn, and in the bulk sediment, 210Pb was measured in order to determine sedimentation rates. The acid-leachable metal concentrations were very low, especially compared to total concentrations measured in Commonwealth Stream sediments. Our results suggest that environmentally available metals in these systems have had little anthropogenic contributions. Our estimated sedimentation rates, between 0.15 and 0.7 cm yr-1, support previous work that has established these streams as highly dynamic and subject to rapid geomorphological changes over the past ~15-20 years.

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Relative terrestrial exposure ages inferred from meteoric-10Be and NO3 concentrations in soils from the Shackleton Glacier region, Antarctica

Melisa Diaz[1,2], Paul Bierman[3], Lee Corbett[3], Byron Adams[4], Diana Wall[5], Ian Hogg[6,7], Noah Fierer[8], Christopher Gardner[1,2], W. Berry Lyons[1,2]

[1]The Ohio State University, Columbus, United States, [2]Byrd Polar and Climate Research Center, Columbus, United States, [3]University of Vermont, Burlington, United States, [4]Brigham Young University, Provo, United States, [5]Colorado State University, Fort Collins, United States, [6]University of Waikato, Hamilton, New Zealand, [7]Polar Knowledge Canada, Cambridge Bay, Canada, [8]University of Colorado Boulder, Boulder, United States

During the Last Glacial Maximum (LGM, approximately 25 ka), the East Antarctic Ice Sheet (EAIS) was larger and thicker than today. Modeling studies and field mapping data have shown that the increase in glacier height was not uniform across the continent, and the outlet glaciers which flow through the Transantarctic Mountains experienced the largest increases in thickness. As a result, ice-free areas which are currently exposed may have been inundated during the LGM, though the timing of glacial retreat is still unknown. We collected depth profiles of soils every 5 cm (up to 30 cm) from seven ice-free areas along the Shackleton Glacier, a major outlet glacier of the EAIS, and measured meteoric-10Be and NO3 concentrations to calculate relative surface exposure ages. We used10Be inventories and published delivery rates to calculate maximum exposure ages, which ranged from 1.67 Myr at Roberts Massif near the Polar Plateau to 495 kyr at Thanksgiving Valley closer to the Ross Ice Shelf. Meteoric-10Be concentrations were measured for three depth profiles of the seven profiles and there is a strong, linear correlation between 10Be and NO3. NO3 concentrations were used to estimate meteoric-10Be inventories for the four other locations. Percent error between the estimated and calculated inventories ranged from ~1-41%. The NO3 derived 10Be inventories were then used to estimate exposure ages. These results show that NO3 concentrations can be used in conjunction with meteoric-10Be to help interpret EAIS dynamics over time.

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The role of wind and subglacial inflow in the hydrological connection between the two lobes of Lake Bonney, east Antarctica

Peter Doran[1], Ian Hawes[2]
[1]Louisiana State University, Baton Rouge, United States, [2]University of Waikato, Hamilton, New Zealand

Lake Bonney in Taylor Valley, east Antarctica, has two distinct lobes separated by a relatively shallow sill in a narrow channel referred to as the Bonny Narrows. Robert Falcon Scott passed through the Bonney Narrows in 1903 on his first expedition in the area and measured the channel width as being “17 feet”. This has allowed us to calculate that the channel was about 1 m deep at the time. Since then lake level has risen over 18 m and the channel is now ~ 80 m wide at its narrowest point. Water chemistry above the sill is similar in the two lobes, but differs significantly below the sill as each lobe has had its own history. West Lake Bonney (WLB) has a hypersaline bottom water, sourced from the underside of Taylor Glacier (also the source of Blood Falls) which is held back from East Lake Bonney (ELB) by the sill. The WLB brine is displaced over the sill and sinks on the ELB side following a former river channel until if finds its neutral buoyancy in ELB, about 6 m below the sill depth. In this presentation, we will show evidence of the nature of this connection. A logging conductivity probe left in the channel for a year shows that the brine overflow events are sporadic and controlled by a combination of water entering from under Taylor Glacier, and strong westerly wind events. We will also discuss impacts of this mechanism for the evolution of ELB chemistry.

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Geochemistry of semi-arid soils on volcanic or sedimentary parent materials from James Ross Island, Antarctica

Mayara Daher[1], Elpídio Fernandes Filho[1], Márcio Francelino[1], Liovando Costa[1], Carlos Schaefer[1]
[1]*Universidade Federal de Viçosa, Viçosa, Brazil*

In most parts of Antarctica, specifically in arid and semi-arid conditions, soils are the results of limited weathering and pedogenesis. The semi-arid soils of Antarctica remains little explored. There, the use of geochemical data is considered an important tool to interpret possible pedological processes through the changing molecular ratios of elements with depth. In this study, the geochemistry of soils developed on different parent materials under a typical semi-arid climate was investigated, based on the quantification of the elements by various methods. Based on the major and trace elements geochemistry, the soil types are clearly differentiated by their geochemical composition, and highly affected by their parent materials. Based on the major elements abundances, chemical weathering is very limited. Using geochemical parameters to identify lithologic discontinuities, five profiles showed this characteristic. The apparent high chemical index of alteration and mineralogical composition, with kaolinite in the clay fraction, soils developed on the marine sedimentary rocks showed a pre-weathered nature, related to the ancient inheritance of Cretaceous paleoclimates, during which warmer climate led to intense weathering under subtropical conditions. Therefore, pre-weathering has a role in the mineralogical composition of Antarctic soils on sedimentary rocks.

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Landforms, soil classification and soil-landscape relationships in Vega Island, Antarctic Peninsula

Rafael Siqueira[1], Carlos Schaefer, Márcio Francelino[1], Elpídio Fernandes Filho[1]
[1]*Universidade Federal De Viçosa, Viçosa, Brazil*

The ice-free areas of Vega Island, located in the Weddell Sea – East Antarctic Peninsula, are environments of complex geomorphological dynamic. We mapped and described the landforms of Cape Lamb, and classified soils according to Soil Taxonomy. Twenty landforms were mapped at a scale of 1:50.000, involving glacial, proglacial, paraglacial and periglacial landforms. The main geomorphological processes were fluvial erosion, gelifluction, aeolian abrasion and rockfalls, responsible by large-scale mass movements. Most soils were classified as Gelisols, notably at the sedimentary lowlands, whereas Entisols were more common in the volcanic highlands. The proglacial domain is represented by recent ice-cored moraines (30%). The soil classes in these landforms are Glacic Psammorthel and Glacic Haploturbel. The periglacial domain (10%) encompasses former, higher and stable surfaces, highlighting the cryoplanation platforms with patterned ground, felsenmeers and “Mesas” (former nunataks). The soil classes are Typic Gelorthent, Lithic Cryorthent and Typic Haploturbel. The paraglacial domain was the more expressive (60%), involving landforms like scree slopes, raised marine terraces, plains, beaches, talus-slopes and boulder fields. The soil classes in scree slopes are Typic Haploturbel and Typic Gelorthent. Typic Gelifluvent and Typic Gelaquent are the soil classes in plains, while Typic Psammorthel are present in marine terraces. The major formation factors of Vega Island landscape are: the geologic control, the glacial dynamic, the summer snow melting, the freeze-thaw cycles and the semiarid climate. The paraglacialism represents a young and transitional landscape recently recovered from last glaciation. Landforms influences directly the soil distribution, determining a strong soil-landscape relationship.

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Use of LIDAR data in the identification of mass movement processes of periglacial landforms on Keller Peninsula, King George Island, Antarctica

Pedro Araújo[1], Elpidio Fernandes Filho[1], Márcio Francelino[1], Carlos Schaefer[1]
[1]*Universidade Federal De Viçosa, Viçosa, Brazil*

The objective of this study was to identify the main geomorphic processes in the landscape of the Keller Peninsula using a terrestrial laser scanner (TLS) technology. For the reference database, it was used a cloud of points obtained in 2015 and a field campaign that was carried out in 2018 to obtain the comparison set. We chose to use the direct comparison technique in the cloud of points, through the algorithm m3c2, realized in the software CloudCompare v.2.10. A cloud of points was obtained with the information of the vertical distance between points, with an average threshold of 0.20 m for significant change detection. The results were related to the present geomorphological features and morphometric variables of the relief. Site one, which comprises part of the glacial circuses present in the area, presented processes predominantly related to crionival and slope systems. The site two comprised part of the Flagstaff Hill, being verified processes involved by gravitational forces and slope processes, with slope being the predominant factor for the changes in talus ramps. The third site presented processes is occurring high altitude, such as falls of cliffs on escarpments, besides crionival processes occurring in ramps and niches. The fourth site was the one which presented the lowest rate of altimetric change, with changes occurring in saturated terrains, positioned in high elevations and moderate slope. The use of Lidar data and high-resolution aerial images proved to be adequate in the identification of geomorphic processes in large areas.

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Landforms, soil classification and soil-landscape relationships in Vega Island, Antarctic Peninsula

Rafael Siqueira[1], Márcio Francelino[1], Carlos Schaefer[1], Elpídio Fernandes Filho[1]
[1]*Universidade Federal De Viçosa, Viçosa, Brazil*

The ice-free areas of Vega Island, located in the Weddell Sea – East Antarctic Peninsula, are environments of geomorphological complex dynamic. We mapped and described the landforms of Cape Lamb-Vega Island, and we classified its soils according to Soil Taxonomy. Twenty landforms were mapped at a scale of 1:50.000, involving glacial, proglacial, paraglacial, and periglacial landforms. The main geomorphological processes were fluvial erosion, gelifluction, aeolian abrasion, and rockfalls, responsible by large-scale mass movements. Most soils were classified as Gelisols, notably at the sedimentary lowlands, whereas Entisols were more common in the volcanic highlands. The proglacial domain is represented by recent ice-cored moraines (30%). The soil classes in these landforms are Glacic Psammorthel and Glacic Haploturbel. The periglacial domain (10%) encompasses former, higher and stable surfaces, highlighting the cryoplanation platforms with patterned ground, felsenmeers, and “Mesas” (former nunataks). The soil classes are Typic Gelorthent, Lithic Cryorthent, and Typic Haploturbel. The paraglacial domain was the more expressive (60%), involving landforms like scree slopes, marine terraces, plains, talus-slopes, and beaches. The soil classes in scree slopes are Typic Haploturbel and Typic Gelorthent. Typic Gelifluvent and Typic Gelaquent are the soils classes in plains, while Typic Psammorthel are present in marine terraces. The main formation factors of Vega Island landscape are the glacial dynamic, semiarid climate, geologic control, ice-cemented permafrost, and concentration of moisture in the summer. The paraglacialism represents a young and transitional landscape recovering from the glaciation. Landforms influence the soil distribution directly, determining a strong soil-landscape relationship.

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Use of LIDAR data in the study of solifluction processes in periglacial landforms on Maritime Antartica

Pedro Almeida[1], Márcio Francelino[1], Elpidio Fernandes Filho[1], Carlos Schaefer[1]
[1]*Universidade Federal De Viçosa, Viçosa, Brazil*

We identified typical periglacial processes in the landscape of the Keller Peninsula using a terrestrial laser scanner (TLS) technology. For the reference database, we used a cloud of points obtained in 2015 and a field campaign that was carried out in 2018 to obtain the comparison set. We chose to use the direct comparison technique in the cloud of points, through the algorithm m3c2, carried out by the software CloudCompare v.2.10. A cloud of points was obtained with the information of the vertical distance between points, with an average threshold of 0.20 m for significant chance detection. The results were related to the observed geomorphological features and measured morphometric variables. Site one, which comprises part of glacial circus showed predominantly crionival and slope process. Site two comprised part of the Rocky outcrop of Flagstaff Hill, where gravitational forces and slope process are predominant factor for the changes of talus down slope. The third site at high altitude, showed rock falls, escarpment retreat and crionival process in ramps and niches. The fourth site was the most stable with the rate of surface changes, mainly in hydromorphic areas at high elevations and moderate slope. The use of Lidar data and high-resolution aerial images proved to be adequate in the identification of changing geomorphic process in periglacial areas of Antarctica.

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UAV image applied in the dynamics of the landforms on Keller Peninsula, King George Island, Antarctica

Pedro Araújo[1], Márcio Francelino[1], Elpidio Fernandes Filho[1], Carlos Schaefer[1]
[1]*Universidade Federal De Viçosa, Viçosa, Brazil*

This work had the general objective of comparing old aerophotographic bases with current images of high spatial resolution generated by Unmanned Aerial Vehicle (UAV), being certified its accuracy according to Brazilian cartography norms. For taking aerial images, used a small-format digital photographic set, embedded in UAV. Data collections were performed in the summers of the years 2018 and 2019, and two different databases were generated. Two sets of aerial images from the years 1956 and 2003 were reprocessed to carry out the temporal analysis of environmental changes. For this, techniques based on the Structure of Movement (SfM) were used. The results obtained were two orthophotomosaics with Ground Sample Distance (GSD) of 0.05 m (2018) and 0.04 m (2019), in addition to two digital terrain models (DTMs), with spatial resolutions of 0.30 m (2018) and 0.38 m (2019). Subsequently, the positional quality analysis was performed on the data obtained in 2019. The products were certified from one of a set of 36 independent points, evaluating the altimetric and planimetric accuracy. The generated products presented planimetric root mean square error (RMSE) of 0.1149 m and altimetric RMSE of 0.2488 m. As for the Cartographic Accuracy Standard for Digital Cartographic Products, the orthophotomosaic was classified as class A and the MDT class B; both tested on the scale of 1: 1000. The data collection and processing technique allowed the analysis of natural and anthropic aspects of the studied area, with promising applications in the assessment of the environmental dynamics of Antarctic ice-free areas.

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Temperature and Moisture Dynamics of the Active Layer in Wet and Dry Soils and Sediments of the McMurdo Dry Valleys, Antarctica

Michael Gooseff[1]
[1]*University Of Colorado, Boulder, United States*

In the McMurdo Dry Valleys, extensive open ground provides opportunity for atmospheric energy exchanges to influence active layer and shallow permafrost states and dynamics. We have monitored active layer moisture, temperature, and in a few cases salinity in locations adjacent to streams, lakes and water tracks, and at locations distal from water bodies for several years. These data reveal the expected annual cycle of freeze in the winter and thaw in the summer, though the shoulder seasons and presence of water clearly provide important controls on the extent of thaw and solute and moisture mobility. We also observe that summer snow accumulation has a significant impact on active layer processes by reducing the connection to soil surface energy fluxes. The implications of changes in water content of the active layer may play a role in affecting habitat for soil microbial and invertebrate communities.

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Blue ice moraines as natural archives

Kathy Licht[1], Christine Kassab[1], Tori Kennedy[2], Bailey McDaniels[1], Michael Kaplan[3]
[1]Indiana University Purdue University Indianapolis, Indianapolis, United States, [2]Tulane University, New Orleans, United States, [3]Lamont Doherty Earth Observatory, Palisades, United States

Our previous work has shown that some blue ice moraines (BIMs) are invaluable quasicontinuous records of Antarctica's glacial history and subglacial processes. To expand this work, we analyzed high-resolution satellite imagery for ~100 moraines to investigate geomorphological patterns on BIMs, which can preserve temporal records of surface conditions. Many BIMs around Antarctica have zones of hummocky topography 10's - 100's m wide at their margin. This differential ice surface lowering is interpreted as a function of locally high ablation rates from (brief) seasonal melt where till cover is thin. This hummocky pattern is inferred to record relatively warm post-LGM conditions. The few BIMs that lack this hummocky topography are located at the highest elevations and/or most southerly locations. Further into the moraine, away from this contact, the pattern typically transitions to ridge/trough or flat topography. The shift indicates a lack of summer melt and/or lower sublimation rates such that the ridge/trough topography more clearly reflect emerging debris bands. Where surface exposure ages are available, this geomorphic change is consistent with the glacial-interglacial transition. In a few instances, hummocky topography appears in older sections of the moraine, reflecting past warmth sufficient to cause differential moraine surface lowering. Lastly, regions of convoluted surface morphology represent dynamic variations in ice input through time. Existing GPR data show consistent internal stratigraphy across BIMs indicating the processes of debris delivery have not changed substantially over time, but changes in debris concentration may be related to geomorphological variations.

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Landforms, geomorphic processes, and soils in a typical periglacial environment of Snow Island, Maritime Antarctica

Davi Lopes[1], FABIO OLIVEIRA[1], CARLOS SCHAEFER[2], WILLIAM RODRIGUES[3]
[1]UFMG, BELO HORIZONTE, Brazil, [2]UFV, VIÇOSA, BRAZIL, [3]UFOP, OURO PRETO, BRAZIL

Despite the progresses in the last decade on periglacial geomorphology and permafrost research in Antarctica, many gaps remain. The present study aimed to identify and describe the main landforms of President Head Peninsula (PHP), Snow Island and investigate the soil–landscape relationships in a typical periglacial environment of Maritime Antarctica. The geomorphological analysis was based on the identification and mapping of landforms and their physiognomic aspects according to the adopted scale: 1:15,000. Landforms were previously identified in satellite images (Sentinel-2), later identified and georeferenced using portable GPS. The map was produced using the ArcGIS 10.1. The map legend includes eighteen (18) landforms classes identified. From the soil survey, we selected surface samples of ten (10) pedons to represent all different landforms. Soil morphological, physical, chemical and mineralogical properties were analyzed. We present the first systematic characterization and geomorphological map of landscapes from PHP. The area was divided into 2 large sectors: (1) sedimentary with paraglacial processes; and (2) igneous with periglacial processes. The paraglacial domain is more dynamic and presents immature and poorly developed soils. The existence of vegetated marine terraces unique to this part suggests the local greater stability and greater nutrients availability. Landforms associated with gelifluction, patterned ground and permafrost were only observed on the upper plateaus. The monitoring of landforms can aid in the understanding of climate changes. The knowledge on soil types and the soil-landscape relationship broaden the understanding of geomorphological aspects and main processes involved in landscape evolution.

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Surface colour and reflectance study to detect weathering rates in a raised beaches system in the South Shetland Islands, Antarctica

Miguel Gomez-Heras[1], Thomas Schmid[2], Jeronimo Lopez-Martinez[1], Jose A. Ortega[1], Belen Oliva-Urcia[1], Rafael Fort[3]

[1]University Autonoma of Madrid, Madrid, Spain, [2]CIEMAT, Madrid, Spain, [3]Instituto de Geociencias (CSIC-UCM), Madrid, Spain

Colour change is often a visible expression of chemical weathering and several chemical weathering processes, such as Fe-rich mineral oxidation, lixiviation and other alteroplasmation processes. Raised beach deposits are a common feature in the South Shetland Islands. These deposits, formed mainly by glacioisostatic evolution, consist of accumulations of rounded centimetre to decimetre size pebbles with no or little soil formation. The lack of soil makes these deposits to stay unmoved for a long time undergoing chemical processes. Surface colour of the pebbles changes as chemical weathering progresses, so a colour gradation, which is proportional to raised beach deposits height (and hence chemical weathering) can be established. This work presents spectral reflectance and surface colour data obtained from measurements carried out with a spectroradiometer (spectral range 350-2500 nm) and a portable spectrophotometer on individual pebbles from raised beaches located at different heights on Livingston Island,. Results show that alterations on the outer rock surfaces induced variations of the spectrum brightness, presence and intensity of characteristic absorption features. Spectral changes in the wavelength range 350-1000 nm were identified and related to the alteration of iron oxide by atmospheric processes or by secondary alteration of iron-rich minerals. Furthermore, spectral features at 2200 nm were related to Al-OH bands. Changes were also expressed in reddening and yellowing as measured with the spectrophotometer. These data are interpreted in terms of the relative age and time of exposure of different beach deposits in the studied system.

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What are the products of chemical weathering of aluminosilicate minerals in the streams of the McMurdo Dry Valleys?

W. Berry Lyons[1], Christopher Gardner[1], Susan Welch[1], Jordan Scheuermann[1], Whitney Gann[1], Kathleen Welch[1]
[1]*The Ohio State University, Columbus, United States*

Research since the early 2000s by a number of McMurdo Dry Valleys (MCM) LTER scientists has clearly demonstrated that chemical weathering of aluminosilicate minerals takes place at high rates when liquid water is present in stream channels of Taylor and Wright Valleys. These processes are thought to primarily occur in the hyporheic zones of these channels where waters of differing residence time react with fresh mineral surfaces. Although there has been speculation that freeze/thaw action may also play a role in weathering processes, little work has been done to establish its importance.

We present three lines of evidence suggesting that the freeze/thaw process in the stream channels may exert a control on the high aluminosilicate weathering rates observed. We have run a series of laboratory experiments simulating freeze-thaw, as well as a frozen control, on crushed igneous rocks from the MCM. The freeze/thaw samples have much less H_4SiO_4 than the control over time, suggesting removal of dissolved Si through freezing. This loss has previously been reported by other authors. Additionally, PHREEQC calculations of major streams in the valleys shows continual undersaturation with respect to amorphous SiO_2 as well as primary minerals found in the stream sediments. Finally, SEM images and EDX spot analyses of reacted surfaces suggest the presence of precipitated amorphous phases coating some of the stream sediments. All of these data imply that freeze/thaw cycles in these streams during the austral summer remove previously solubilized H_4SiO_4, thus potentially increasing the rate of aluminosilicate mineral weathering in these systems.

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The Development of Blockfields in Western Dronning Maud Land: A New Model

Ian Meiklejohn[1], Christel Hansen[2]
[1]*Rhodes University, Grahamstown, South Africa,* [2]*University of Pretoria, Pretoria, South Africa*

Blockfields are ubiquitous in Western Dronning Maud Land where the lithology is doleritic. We suggest a model for the development of autochtonous blockfields. The landforms originate after pre-preparation of the rocky material through extensive and prolonged weathering and dilitation after deglaciation. Intact bedrock is heaved into a disordered matrix that has no directional fabric by wedging that results from expansion when water from snow and ice melts penetrates joints and cracks freezes. Where a nunatak does not have either the pre-prepared matrix or sufficient moisture to cause ice-wedging, the surface is left intact and only the original joints and cracks. Our model helps to explain the existence of disjointed and chaotic rocky surfaces in the Ahlmannryggen. The development of the blockfields is a precursor to paedogenesis and the development of other permafrost and active layer landforms that provide a habitat for biological colonisation.

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Substrate preferences by iron(III)-reducing bacterial communities on iron oxide minerals after glacier retreated in polar and subpolar zones

Carolina Merino[1,2,3], Francisco Matus[1,2,3], Ignacio Jofré[2,3], Francisco Najera[2,3]

[1]Center of Plant, Soil Interaction and Natural Resources Biotechnology Scientific and Technological Bioresource Nucleus (BIOREN),Universidad de la Frontera, Temuco, Chile, [2]Network for Extreme Environmental Research, Universidad de la Frontera, Temuco, Chile, [3]Laboratory of Conservation and Dynamic of Volcanic Soils, Department of Chemical Sciences and Natural Resources, Universidad de La Frontera, Temuco, Chile

As glaciers retreats a new development of soils start, while the glacier front formerly covered with ice, undergo a succession of organisms. In this area there is a gradient of iron from ferrihydrite (FH) to a more crystalline forms like goethite (GT), hematite (HT) and magnetite (MT). Under anaerobic conditions, Fe-oxides can be easily reduced to soluble Fe(II) from iron reducing bacteria (IRB). There is growing evidence that the more crystalline Fe may support IRB in lower temperatures as terminal electron acceptors. We postulate that microbial reduction of poorly crystalline Fe can decompose more polymerized carbon (C) with lower turnover than more crystalline Fe with labile C. FH has more reducing capacity than MT, which allows microorganism to decompose fast simple substrates (e.g. acetate). A microcosm (liquid media) was prepared whit IRB extracted from Antarctic soil (glacial front) and incubated (5 ºC) with sterilized Fe-oxides combined with glucose, lactate and acetate. In addition, the catalysis of 19 L-amino acids (AA) were tested for enzymatic production. The results showed that the release of CO2 was maximal (235 mg kg-1 soil) for acetate-MT followed by GT = HT and glucose-FH. Acetate-MT solubilized a significant amount of Fe(III), since Fe(II) increased in 362%, while glucose-FH was the lowest. A positive and highly significant correlation (R2= 0.93) was obtained between AA catalysis and the enzymatic activity with acetate-MT. This activity increased linearly with the crystallinity of Fe-oxides. Therefore, the maximal Fe reduction should be in Antarctic soils with labile C and crystalline Fe-oxides.

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Active Layer Thickness at Seymor Island

Roberto Michel[1], Carlos Schaefer[2], Márcio Francelino[2], Davi Gjorup[2], Pedro Almeida[2]
[1]Uesc, Ilhéus, Brazil, [2]UFV, Viçosa, Brazil

Climate change attention has grown in the 21st century; in 2020 record temperatures were reported at Antarctica catching the attention of the news worldwide. The permafrost is acknowledged as a crucial element for understanding future tendencies. Understanding of Antarctic permafrost is poor, especially at the Weddell Sea zone. Soil temperature records over transitional climatic zones are fundamental for understanding climate change at Antarctica. A monitoring site was installed at the northern sector of Seymour Island in the summer of 2011 (103 m a.s.l., -56,663917W / -64,25545S). It consists of 5 thermistors, an air temperature probe, (100 cm over the soil surface), recording data hourly from March 2011 until Feburary 2016. The active lawyer thickness was calculated as the 0 ˚C depth by extrapolating the thermal gradient. The variability of the active layer thickness shows great contrasts between years, the temperature at 5 cm reaches a maximum daily average (8.3˚C, 2011) in mid December, a minimum (-30.3, 2011) in late July. At 100 cm maximum temperature (0.7 ˚C, 2016) occurs in early February and the minimum (-19.4 ˚C, 2011) was recorded around late July. The active layer thickness increases from 2011 to 2012 (102,2 cm to 113,1 cm), decreasing in the next two years (73,79 cm and 89,08 cm) and assumed a increasing tendency in 2015 reaching its maximum thickness of 123,4 cm in 2016. The active layer thermal regime in the studied period was characteristic of periglacial semi-desert environments, with extreme variation in surface and negative temperatures even during summer.

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Geology and geomorphology of Seymour Island (Marambio) (NW Weddell Sea). new maps and accompaigned book

Manuel MONTES[1], Sergio SANTILLANA[2], Francisco NOZAL[1], Roberto RODRIGUEZ FERNANDEZ[1]
[1]Geological Survey Of Spain (IGME), , SPAIN, [2]Argentine Antarctic Institute (IAA) , San Martín,, ARGENTINE

Recently, new Antarctic maps with scientific memoir: 'Geology and Geomorphology of Seymour Island (Marambio)' was released. Maps and book have been edited by Geological Survey of Spain (IGME) and Argentine Antarctic Institute (IAA), in an international collaborative effort support from both institutions and Spanish Polar Programme, within the new "Antarctic Geoscience Cartographic Series" of the IGME. This work, together with the "Geology and Geomorphology of Hope Bay", constitutes the two first products of the mentioned series.
The Geological and Geomorphological maps (scale 1:20,000) of Seymour Island (Marambio) (NW Weddell Sea) cover its entire surface. The absence of permanent ice permits to observe the unique outcropping series for the reconstruction of the Cretaceous-Paleogene geological history in southern latitudes, included the mapped outcrop of most continuous extension of the K-Pg boundary and the southernmost one of the planet.
The fossil record is singularly rich and abundant in groups like: ammonites, vertebrates, micropaleontology, paleobotanic and mollusk accumulations (coquinas), among others. In addition, the upper strata of Seymour Island (Marambio) next to the Eocene-Oligocene boundary in age, record the opening of the Drake Passage, which contributed to the thermal isolation of Antarctica and global cooling and the beginning of the development of the present-day Antarctic ice sheet.
These maps can help to protect this paleontological heritage.

Reference: Montes, M. et al (2019). Geología y Geomorfología de isla Marambio (Seymour). (Montes, M.; Nozal F. y Santillana, S., eds.). Serie Cartográfica Geocientífica Antártica; 1:20.000, 1ª edición. Acompañado de mapas. Madrid-IGME; Buenos Aires-IAA, 300p.

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Exposure age, provenance, and weathering of glacial tills Ong Valley, Antarctica

Dan Morgan[1], Emma Rimmer[1], Ellie Miller[1], Evan Miranda[1], Andrew Grant[1], Greg Balco[2], Warner Cribb[3], Marie Bergelin[4], Dr. Jaakko Putkonen[4]

[1]Vanderbilt University, Nashville, United States, [2]Berkeley Geochronology Center, Berkeley, United States, [3]Middle Tennessee State University, Murfreesboro, United States, [4]University of North Dakota, Grand Forks, United States

Ong Valley, Antarctica contains a sequence of three tills, two of which are underlain by relict glacial ice. We use the concentration of cosmogenic Beryllium-10 and Neon-21 in quartz from bedrock and glacial boulders to determine the exposure age of the glacial tills. We collected bedrock samples above the glacial limit, and calculated long-term rates of erosion using the concentration of cosmogenic Ne-21 in quartz from the bedrock, yielding rates of 0.14 – 0.41 m/Ma. Be-10 and Ne-21 exposure ages of the lateral moraine closest to the older ice body are at minimum 1.1 Ma, indicating the ice is at least that old. A second lateral moraine in between the two ice bodies yields an exposure age of at least 475 ka, providing an apparent maximum age for the younger ice body. We extracted detrital zircon minerals from the glacial tills, the buried ice, and from the modern ice front to use as a proxy for the provenance of the glacial tills in Ong Valley. The distribution of the Uranium-Lead ages of the zircon minerals from each till are statistically the same, indicating that the provenance of each till is the same. We interpret this to mean that the Argosy Glacier that deposited the tills in Ong Valley had the same flow patterns to deposit each till. Additional data on the chemical index of alteration of the bedrock and tills, and aerosol salt accumulation in the tills indicate a weathering-limited environment in Ong Valley.

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Biogeochemical cycling of dissolved trace metals in freshwater lakes of Larsemann Hills, East Antarctica

Mohammad Nuruzzama, Waliur Rahaman, Rahul Mohan
[1]*National Centre For Polar And Ocean Research, Vasco Da Gama, India*

Coastal lakes in Antarctica during austral summers receive enormous solutes such as major ions and trace elements, of which some of them are used as nutrients that support biological productivity in these lakes. Freshwater lakes in Antarctica are hotspots of biological activities and inorganic precipitation, characterised by high rates of nutrient attenuation and salt-formation. We have investigated trace metals along with biological parameters (dissolved organic carbon and chl.a) to understand their role in nutrient dynamics and biogeochemistry of freshwater lakes of Larsemann Hills, East Antarctica. The concentrations of dissolved trace metals are in sub-nanomolar range, an order of magnitude lower than global rivers which limit the primary productivity such as chl. a concentration (0.24 ± 0.19 mg/l) and supports the oligotrophic characteristics of the lake waters. In the present study, dissolved Mo is identified as limiting micro-nutrient among the trace elements (e.g. Cu, V, Mn, Ba, Cd, Cr, Co, U) studied in these lakes. Whereas an active role of dissolved Cu in organic decomposition was observed in the lakes. Inorganic and/or biological mediated precipitation of Ba and Mn are widespread on the lake sediments. Evaluation of Ba excess estimated for lake sediments varies from 25-50% also supports these findings and suggests the inorganic attenuation in the lakes. Overall, this study explains the individual responses and behaviour of trace metals in the Antarctic lakes. This work is of great importance to better understand the biogeochemical cycling of trace element and their critical role in the nutrient-deficient lakes in the Antarctic environment.

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Geomorphological processes in advancing moraines: A comparison between two proglacial areas in Antarctica

Carina Petsch[1], Rafaela Mattos Costa[2], Kátia Kellem da Rosa[2], Luiz Felipe Velho[3], Maria Eliza Sotille[2], Rosemary Vieira[4], Jefferson Cardia Simões[2]

[1]Federal University of Santa Maria, Santa Maria, Brazil, [2]Federal University of Rio Grande do Sul, Porto Alegre, Brazil, [3]Federal Institute of Rio Grande do Sul, Porto Alegre, Brazil, [4]Fluminense Federal University , Niterói, Brazil

This work assesses the morphological consequences of recent (post-'Little Ice Age'-LIA) paraglacial reworking of advance moraines in two areas: Hope Bay (HB) in the Antarctic Peninsula and Fildes Peninsula (FP) in King George Island, South Shetlands. We have analyzed hydrological processes, topography, snow melting, slope exposure, slope, particle-size, vegetation, and exposure time of the advancing moraines. In both areas, there is a later-frontal hummocky morainic complex, formed by glaciers that advanced during the LIA. Gully systems are observed in the steepest portions of FP and HB, forming debris cones, which already have a vegetation in the former one. The FP advance moraines are 100 m from the Collins glacier terminus, in the ice-marginal environment, are 8 to 10 m high and about 1.5 km long. The sedimentary material is varied, from large blocks to silt and clay. Low slope moraines near the Maxwell Bay (FP) are covered by vegetation fields of up to 0.03 km², denoting a reduction in geomorphic activity in this area. However, active slumping can also be observed in the FP moraines, but in the ice-distal face, associated with steep slopes. The HB moraines are about 300 m distant from the Buenos Aires glacier and are 500 m long. Boulders predominate, where lichen fixation occurs. Some moraines are surfaced deformed, due to melting of internal ice. The different evolutionary stages of the proglacial environment are explained by the location of the moraines, vegetation fixation, morphometry and granulometry of the sediments.

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The Geomorphons Method applied to the identification of glacial relief forms in the ice-free areas of King George Island

Carina Petsch[1], Cleiva Perondi[2], Kátia Kellem da Rosa[2], Rosemary Vieira[3], Jefferson Cardia Simões[2]
[1]Federal University of Santa Maria, Santa Maria, Brazil, [2]Federal University of Rio Grande do Sul, Porto Alegre, Brazil, [3]Fluminense Federal University, Niterói, Brazil

This study aims to contribute to the understanding of the relief of ice-free environments in Antarctica, presenting a method of automatic classification of paraglacial and glacial landforms, called Revised Geomorphon Digital Classification (RGDC). This method was applied using the textural similarity of the References Elevations Models of Antarctica (REMA) 8 for ice-free areas of Potter Peninsula (PP), Fildes Peninsula (FP) and foreland of Fourcade Glacier (FG) and Ecology Glacier (EG) in King George Island, South Shetlands, Antarctica. The relief elements identified by the methodology are related to the erosive and depositional glacial forms at macro and meso scale (advance moraines, circus and U valleys, horns and aretes). Elevated beaches at FP and PP areas were classified, there it is possible to observe a sequence of features that correspond to different moments of land rise after deglaciation. The method was unable to identify features such as eskers and moraines of recession in PP, FG and EG, which are forms of mesoscale, and discontinuous moraines that weren't identified in the crest class. Older forms in deglaciated areas, as in FP, have been reworked difficulting the identification by the Geomorphon method, due to the smoothing of the forms and less roughness. Data from previous mappings and observations from fieldwork (2015, 2016 and 2019) showed that RGDC and REMA 8 data can be applied to geomorphological mapping aimed at paleoglaciological studies.

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Cryosols in sorted patterned ground at Nelson Island, Maritime Antarctica: properties, mineralogy and micromorphology

William Rodrigues[1], Fábio Oliveira[2], Carlos Schaefer[3], Davi Lopes[2]

[1]Universidade Federal de Ouro Preto/INCT da Criosfera, Departamento de Geologia, Belo Horizonte, Brazil, [2]Universidade Federal de Minas Gerais/INCT da Criosfera, Departamento de Geografia, Belo Horizonte, Brazil, [3]Universidade Federal de Viçosa/ INCT da Criosfera, Departamento de Solos, Viçosa, Brazil

In polar regions, patterned ground (PG) is considered one of the most distinctive surface feature with permafrost, as well as one of the main periglacial features of Maritime Antarctica. Despite all previous works on physical properties and formation mechanisms for PG reported in the Antarctic environment, little attention was given to their chemical and micromorphological attributes. In this study, we evaluated the development degree of PG soils in ice-free areas of Harmony Point, Nelson Island, Maritime Antarctic. Three pedons were selected for physical, chemical, mineralogical, micromorphological and micromorphometric analyses. The most developed PG Turbic Cryosol shows clay loam texture in the central mudboil, and skeletal composition at the external ring. Smectite and kaolinite are the main clay minerals. Micromorphological analysis in the external ring indicates strong frost action manifested by a vesicular microstructure. The clayey mudboils present a block microstructure, separated by thin and elongated planar pores due to frost shrinking processes. Little chemical weathering was inferred by preservation partially saussuritized plagioclases in the coarse material. The micromorphometric analysis showed circular rotation grains orbiculic, controlled by the cryoturbation process. Pedofeatures as silt and silt-clay cappings occur on rock fragments, jointly pores with complete and discontinuous in-filling with organo-mineral material. Permafrost was ubiquitous and cryoturbation is a key soil-forming process in these areas. With these characteristics in mind, one can consider that Harmony Point processes one of the most extensive and well-formed of sorted patterned grounds with cryoturbated mudboils in South Shetland Island, with varying degrees of development and plant colonization.

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Sampling methodology for characterization of geochemical and microbiological impact of acid rock drainage in seawaters and sediments from Cardozo Cove, Antarctica.

Silvia Rosas[1], Gabriel Tasayco[1], Eduardo Tirado[1], Axel Schippers[2], Bernhard Dold[3]
[1]Geological Engineering, Pontifical Catholic University Of Peru, Lima, Peru, [2]Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Hannover, Germany, [3]Lulea University of Technology (LTU), Lulea, Sweden

We present the methodology and first preliminary results from the Peruvian Antarctic campaign ANTAR XXVII. The aim of this investigation is to study the effect of acid rock drainage (ARD) in the water column and in sediments. The ARD was reported for the first time previously from the Cardozo Cove in King Georg Island, Southern Shetland Islands, Antarctica by Dold et al. (2013). The ARD formed through oxidation of sulfide (~10% pyrite) containing rock units, occurring in the coastal part of the bay, liberating important amounts of Fe and associated elements to the sea. In order to track the biogeochemical processes along the flow path from the source to the open sea, three sampling locations were selected along the Cardozo Cove. Sampling was done in the water column by using a rosette with 24 Niskin bottles, including a CTD for physical parameters (T, Conductivity, dissolved O_2). Sediment cores were obtained by a piston corer (obtained cores ranged from 1 - 2.5 m). Pore water was extracted by Rhizon samplers and conserved for cation and anions. Samples for microbiological characterization and petrographical/geochemical analyses were taken from the sediment profiles at the same depth than the pore water samples.

Dold, B., Gonzalez-Toril, E., Aguilera, A., Lopez-Pamo, E., Cisternas, M.-E., Amils, R. (2013). Acid rock drainage and rock weathering in Antarctica – important sources for iron cycling in the Southern Ocean. Environmental Sciences & Technology. 47(12). 6129–6136.

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Digital soil mapping of functional soil properties of the McMurdo Dry Valleys

Pierre Roudier[1,2], Ashley Shaw[4], Jasmine Lee[5], Charles Lee[3], Craig Cary[3], Tanya O'Neill[3], Fraser Morgan[1,2]
[1]Manaaki Whenua - Landcare Research, Palmerston North, New Zealand, [2]Te Pūnaha Matatini, Auckland, New Zealand, [3]University of Waikato, Hamilton, New Zealand, [4]University of Oregon, Eugene, USA, [5]Monash University, Clayton, Australia

While microbiologists face a range of questions concerning the biodiversity of terrestrial systems in ice-free regions, a major hurdle is the sparse coverage of soil information. The spatial distribution of microbiological communities has been shown to be strongly influenced by soil attributes (eg water content, salinity, organic carbon, pH). But while pedological maps have been published for various ice-free regions across the continent, the spatial distribution of those soil attributes themselves is largely unknown.

The use of digital soil mapping (DSM) has been tested to address this lack of soil attributes information: local soil observations, derived from a range of legacy studies, but also from data of opportunity collected every season, can be combined with a range of spatial layers reflecting different factors of soil formation using a machine learning model, in order to predict the spatial distribution of soil attributes measured at those locations.

Here, we are collating and harmonising data from different studies to investigate the spatial distribution of pH, one of the critical soil properties for understanding life distribution in Antarctic soils. Since other parameters of interest are also measured, this opens an opportunity to extend this soil information system to other important soil properties for the region (eg salinity, carbon).

The application of those digital soil mapping techniques can (i) be a tool to understand and predict where microbial habitats occur, and (ii) has the potential to generate base layers for researchers outside the soil science community (in particular the fields of microbiology and climate change).

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An early deglaciation at sub-Antarctic Marion Island from cosmogenic 36Cl exposure dating: implications for landscape development

Elizabeth Rudolph[1,2], David W Hedding[3], Werner Nel[2]
[1]University Of The Free State, Bloemfontein, South Africa, [2]University of Fort Hare, Alice, South Africa, [3]University of South Africa , Florida, South Africa

Glacial oscillations of the Quaternary provide valuable insights into past and present climate linkages. For the Southern Ocean, the sub-Antarctic Islands provide a valuable terrestrial record of glacial chronologies, since they are unique, not only in size and topography, but also in oceanic situation when compared to other continental landmasses (e.g. Antarctica or Patagonia). On Marion Island, southern Indian Ocean, rates of periglacial processes, soil and peat formation, and ecological succession were largely based on the premise that the island was under full glacial conditions during the global Last Glacial Maximum (LGM) and had undergone rapid deglaciation prior to the Holocene. Here we present a new glacial chronology for Marion Island from cosmogenic 36Cl exposure dating of glacial erosional and depositional features. Exposure ages of coastal moraine boulders show that the onset deglaciation was prior to ~35 ka ago and by the peak of the global LGM (~20 ka ago) bedrock surfaces at 850 m a.s.l. were already exposed. No evidence of Holocene re-advances, e.g. during the Antarctic cooling period, have yet been found, but these would have been restricted to the island's interior above 900 m a.s.l. We suggest that, during the gLGM, a combination of Antarctic sea-ice expansion, the northward migration of the southern westerly winds and oceanic fronts brought drier conditions to Marion Island, causing glacial retreat instead of advance. Our findings require a re-evaluation of the location and timing of the ice-free areas which acted as biological refugia and primers for periglacial landscape development.

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Active layer thermal regime at three different plant communities at Maritime Antarctica

Daniela Schmitz[1], Roberto F.M. Michel[2], Flávia R. Ferrari[1], Marcio R. Francelino[1], Carlos E. G. R. Schaefer[1]
[1]Departamento de Solos, Universidade Federal de Viçosa, Viçosa, Brazil, [2]Universidade Estadual de Santa Cruz, Ilhéus, Brazil

Soil temperature and moisture regimes are key drivers of abiotic and biotic processes in the Antarctic region. These environmental variables are considered essential in any consistent monitoring of global climate changes affecting the permafrost and active layer. In this work, we analyzed changes in the thermal and hygrometric regimes at fine-scale in three Cryosols of Elephant Island, Maritime Antarctica, under different vegetations. We selected three sampling pedoenvironments, with contrasting soil properties and plant communities. Ten plots (20 × 20 cm) were established in each pedoenvironment. Vegetation coverage, soil properties, air temperature, and soil temperature and moisture at three depths (10, 20, 30 cm) were measured. Three distinct communities were identified in different soil types: moss carpet community (MCC) with Turbic Leptic Reductaquic Cryosol; fruticose lichen community (FLC) in a Turbic Leptic Skeletic Cryosol, and moss turf community (MTC) in a Turbic Leptic Eutric Skeletic Cryosol. Our results showed that MCC had higher vegetation cover, which promoted higher temperatures at the active layer. Plant coverage has allowed to conserve higher values of soil temperature with less variability, as well as to reduce evaporation, despite high soil moisture contents observed in MCC. We infer that an increase in soil temperature promotes higher organic matter decomposition that results in higher soil fertility by cycling in MCC. The plant coverage has an important role in mediating soil temperatures and moisture variation at a fine spatial scale in the Antarctic ecosystem.

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Remote Sensing and Mapping of Debris Covered Ice Masses; Transantarctic Mountains, Antarctica

Miranda Shanks[1], Jaakko Putkonen[1], Taufique Mahmood[1]
[1]*University of North Dakota, Grand Forks, United States*

In the Transantarctic Mountains (TAM), a limited number of buried ice masses have been discovered. These ice masses are buried underneath < 1 m of till which thermally shields them and limits sublimation thus preserving the ice. An example of such is found in Ong Valley, with sublimation till at >1.1 Ma years old, consequently making it one of the oldest known ice masses on Earth. This ice can yield information on paleoclimate, past atmosphere, and ancient organisms.
In addition to a few known locations, no systematic effort has been made to map such ice masses in Antarctica. This research is motivated by the potential trove of paleoproxies harbored in these ancient ice bodies.
We use remotely sensed imagery (World View) to identify locations for these buried ice masses. The imagery consists of four spectral bands in the blue, red, green, and near-infrared region of the electromagnetic spectrum with sub-meter spatial resolution. The visual detection of landforms associated with buried ice masses combined with digital elevation model allows us to uniquely identify the buried ice masses. To develop and refine our technique we used Ong Valley, Antarctica for ground truthing.
We expect to find a small number of the buried ice bodies which will allow us to study the spatial and elevation patterns. This project has a potential to extend further back in time our understanding of the ice-sheet fluctuations and paleoclimate.

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Thinning history of Byrd and Mulock Glaciers: A preliminary field report

Jamey Stutz[1], Shaun Eaves[1], Kevin Norton[2], Dan Lowry[3], Brent Goehring[4], Greg Balco[5]
[1]Antarctic Research Centre, Victoria University Of Wellington, Wellington, New Zealand, [2]Victoria University of Wellington, Wellington, New Zealand, [3]GNS Science, Lower Hutt, New Zealand, [4]Tulane University, New Orleans, United States, [5]Berkeley Geochronology Center, Berkeley, United States

Response of the West Antarctic Ice Sheet (WAIS) to projected warming remains a significant uncertainty in sea level rise projections. The aim of this project is to provide understanding of past mechanisms and feedbacks of ice sheet retreat, to reduce uncertainty in projections of future change. We will extend the observational record of ice sheets by targeting strategic locations around the margins of the Ross Ice Shelf, where glacial sediments deposited on nunataks next to dynamic ice margins record the transient evolution of the ice surface elevation immediately prior to the observation period. Our cosmogenic surface exposure chronologies from these sites will quantitatively constrain (i) past rates of ice thinning; (ii) total magnitudes of ice elevation change; and (iii) the absolute timing of ice discharge and thinning events in these sensitive regions. Our new ice thinning histories will inform high-resolution, regional-scale numerical glacier model experiments, in which we will determine the surface mass balance and ocean-heat drivers of ice discharge events.

Field work undertaken during the 2019-20 field season focused on outcrops along the Byrd and Mulock glacier catchments. Overall, ~30 samples of bedrock and glacial erratics were collected for cosmogenic surface exposure dating. Main highlights include i) erratic cobbles found at Lonewolf Nunataks indicate that upper Byrd Glacier has previously been at least 250 m thicker than present and ii) Striated bedrock surfaces and glacial erratics found mid-way up Mt. Marvel indicate that Mulock Glacier was previously thicker, and that local flow paths were different to present.

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Presence of Meteoric Beryllium-10 in Miocene Sediments Challenges Permanent Polar Aridity in the McMurdo Dry Valleys

Marjolaine Verret[1], Warren Dickinson[1], Kevin Norton[2], Denis Lacelle[3], Marcus Christl[4], Richard Levy[1,5], Tim Naish[1]

[1]Antarctic Research Centre, Victoria University of Wellington, Wellington, New Zealand, [2]School of Geography, Environment and Earth Sciences, Victoria University of Wellington, Wellington, New Zealand, [3]Department of Geography, Environment and Geomatics, University of Ottawa, Ottawa, Canada, [4]Department of Physics, ETH Zürich, Zürich, Switzerland, [5]GNS Science, Lower Hutt, New Zealand

Many studies suggest that at high elevations, the McMurdo Dry Valleys have remained frozen under a hyper-arid polar climate since ca.12.9 Ma. Ground ice is ubiquitous in subsurface sediments at these elevations, and its presence in sediments dating back to the Mid-Miocene (ca.14 Ma) is at the center of the debate regarding the onset of permanent aridity. Recent studies using met^{10}Be as a tracer for water infiltration in two nearby high elevations sites yield conflicting results. Dickinson et al. (2012) found significant met^{10}Be concentrations down to 4.5 m at Table Mt. (77°57'S, 161°57'E, 1945 m a.s.l) suggesting infiltration of liquid water during warmer periods well after 12.9 Ma, whereas Valletta et al. (2015) did not detect met^{10}Be within 60 cm at Friis Hills (77°45'S, 161°30'E, 1200 – 1500 m a.s.l), supporting persistent polar aridity and opening up a debate on leaching methods. Here, we investigated both sites using the same leaching method as Valletta et al. (2015), measuring met^{10}Be in a 5 m core at Friis Hills and samples from the Dickinson et al. (2012) study at Table Mt. Our results show that met^{10}Be is present down to a depth of 5 m at both sites, in concentrations 2 – 4 orders of magnitude greater than those found by Valletta et al. (2015). These findings show that water infiltration occurred after the emplacement of the sediment, indicating warm and wet periods through the late-Miocene and Pliocene; findings which are supported by the isotopic signature of the near-surface ground ice.

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Understanding the landscape evolution of the Fildes Peninsula (King George Island, Antarctica) through carbon and nitrogen analysis

M. Muniz[2], R. Anjos[3], R. Cardoso[4], J.P. Felizardo[5], M. Vezzone[6], R. Vieira[1]

[1]Institute of Geosciences, Fluminense Federal University, Niterói, Brazil, [2]Institute of Physics, Fluminense Federal Univrsity, Niterói, Brazil, [3]Institute of Physics, Fluminense Federal Univrsity, Niterói, Brazil, [4]Institute of Physics, Fluminense Federal Univrsity, Niterói, Brazil, [5]Institute of Physics, Fluminense Federal Univrsity, Niterói, Brazil, [6]Institute of Physics, Fluminense Federal Univrsity, Niterói, Brazil

Over the last century, the Maritime Antarctica region is suffering because of the global climate change effects. The glaciers are retracting, resulting in more ice-free areas and more soil exposition, which the changes promote influence at the structure and modify the landform. This work shows preliminary data from Fildes Peninsula, King George Island, which correlate the dynamics of the soil and its composition and nutrient content. Analysis of stable isotopes of carbon and nitrogen were carried out in two sediment profiles, in addition to samples of the main sources of sediment and organic matter in the Fildes Peninsula. The results reveal that the values of δ13Corg (-19.3‰ to -21.5‰) and δ15N (-1.4‰ to 4.6‰) are more positive as compared to the soil profile from the Collins Glacier proglacial area (δ13Corg = -20.6‰ to -23.8‰ and δ15N = -3.0‰ to -0.2‰), suggesting a significant influence of marine animals on the carbon and nitrogen contents in the soil. From these findings, a mixture model was applied to understand the influence of the nutrient inputs and the drainage systems in this region in the last thousand years.

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Comparing weathering alteration of sediments from distinct zones of Antarctica: Ellsworth Mountains, South Shetland Islands and Antarctic Peninsula

R. Vieira[1], J. Ferreira[2], J.M. Lirio[3], S. Coria[4], P. Ader[5], V. Costa[6], J. Galvão[7], P. Cardoso[8], F. Ferreira[9], A. Sanders[10], K.K. Rosa[11], M. Muniz[12], R.M. Anjos[13]

[1]Institute of Geosciences, Fluminense Federal University, Niterói, Brazil, [2]Institute of Geosciences, Fluminense Federal University, Niterói, Brazil, [3]Argentine Antarctic Institute, Buenos Aires, Brazil, [4]Argentine Antarctic Institute, Buenos Aires, Brazil, [5]Argentine Antarctic Institute, Buenos Aires, Brazil, [6]Institute of Geosciences, Fluminense Federal University, Niterói, Brazil, [7]Institute of Geosciences, Fluminense Federal University, Niterói, Brazil, [8]Institute of Geosciences, Fluminense Federal University, Niterói, Brazil, [9]Institute of Geosciences, Fluminense Federal University, Niterói, Brazil, [10]Institute of Geosciences, Fluminense Federal University, Niterói, Brazil, [11]Institute of Geosciences, Rio Grande do Sul Federal University, Porto Alegre, Brazil, [12]Institute of Physics, Fluminense Federal University, Niterói, Brazil, [13]Institute of Physics, Fluminense Federal University, Niterói, Brazil

This work presents the initial results of geochemical analysis, based upon the interpretations and comparison of lacustrine and terrigenous fine-grained sediments from distinct glaciated and ice-free areas of Antarctica: Ellsworth Mountains (Patriot and Independence Hills, Union Glacier), South Shetland Islands (King George Island and Deception Island), and Antarctic Peninsula (Trinity Peninsula, James Ross Island and Vega Island). Silt samples were analyzed by the Malvern laser light scattering granulometer. The concentrations of major elements were determined by Energy-dispersive X-ray Spectroscopy in <0,062 mm grain-size fraction. The mineralogical composition was determined by X-ray diffraction using Brucker D8 Advance x-ray diffractometer. Chemical Index of Alteration was applied. Initial results point to Chemical Index of Alteration with moderates values between 56.0-73.8 (average – 63) in some sectors of King George Island, but incipient values between 26,3-52,0 in James Ross and Vega Islands (average – 33,9). Incipient values are also observed in the Ellsworth Mountains but are higher in Patriot and Independence Hills (between 11,0-50,8 / average – 32,4) than in Union Glacier (between 1,5-51,2 / average – 27,4). In comparison with continental Antarctica, the South Shetland Islands and some sectors of the Antarctic Peninsula have a higher level of chemical weathering because they have been deglaciated earlier, the temperatures above zero and high summer humidity in the last six decades. Nevertheless, divergent values are found in the same regions, which may infer that the climatic, geological and topographic conditions play an important role in the composition and concentration of the elements in the sediments.

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Sedimentary analysis of Boeckella Lake Bottom Sediment, Trinity Peninsula, North Antarctic Peninsula

P. Cardoso[7], R. Vieira[1], J.M. Lirio[2], S. Coria[3], P. Ader[4], A. Sanders[5], F. Ferreira[6], M. Muniz[8], R.M. dos Anjos[9]
[1]Institute of Geosciences, Fluminense Federal University , Niterói, Brasil, [2]Argentine Antarctic Institute, Buenos Aires, Argentina, [3]Argentine Antarctic Institute, Buenos Aires, Argentina, [4]Argentine Antarctic Institute, Buenos Aires, Argentina, [5]Institute of Geosciences, Fluminense Federal University, Niterói, Brazil, [6]Institute of Geosciences, Fluminense Federal University, Niterói, Brazil, [7]Institute of Geosciences, Fluminense Federal University, Niterói, Brazil, [8]Institute of Physics, Fluminense Federal University, Niterói, Brazil, [9]Institute of Physics, Fluminense Federal University, Niterói, Brazil

The work will present climatic and environmental information of the deglaciated area of Trinity Peninsula, Antarctic Peninsula, based upon the interpretation of bottom sediment from Boeckella Lake. By the geochemical, mineralogical and isotopic composition of the sediments, in addition to granulometric and morphoscopic analysis, the work will also correlate the results with the temperature rise in the region. Elevated temperatures since the mid-20th-century in the Antarctic Peninsula region have generated extensive ice-free areas, and consequently, more exposed to the atmospheric and erosive events. Lake Boeckella, the largest water body, and former water supply to the Argentine Hope Base had 67.454 m2 and maximum depths between 7 and 9 m, with major contribution of melting water flow, mainly in the summer months, from the snow and Buenos Aires glacier. After two events of overflowing since the 2000s, the lake began to dry up and shrunk in two separated ponds. The lake floor and the past levels became exposed due to the fall in water level, and sediment samples could be collected during the fieldworks in January/February 2019, headed by the Holocene Lakes Project of Argentine Antarctic Program. CAMSIZE analyzer obtains the particle size distribution of sand fractions, and the silt samples are analyzed by the Malvern laser light scattering granulometer. The concentrations of major elements are determined by Energy-dispersive X-ray Spectroscopy, in <0,062 mm particle-size distribution. The mineralogical composition is determined by X-ray diffraction using the Brucker D8 Advance x-ray diffractometer. Chemical Index of Alteration is also applied.

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Environmental magnetic properties of surficial soils from Larsemann Hills, East Antarctica: An Insight into pedogenesis

Anish Kumar Warrier[1], Mahesh Badanal[2], Abhilash Nair[2], Rahul Mohan[2], Rajasekhariah Shankar[3]
[1]Manipal Academy Of Higher Education, Udupi, India, [2]National Centre for Polar and Ocean Research, Vasco-da-Gama, India, [3]Mangalore University, Mangalore, India

It is well-known that topography, time, lithology, organic matter and climate are mainly responsible for the formation of soils. However, in the polar deserts of Antarctica, geomorphic and soil development processes are hindered by a combination of low temperature, low moisture and freezing conditions. In this study, we report the environmental magnetic properties (concentration, mineralogy and grain size) of 67 surficial soils from Larsemann Hills, East Antarctica with an aim to understand pedogenesis. Magnetic susceptibility values for these soils show a wide range of values ranging from 14.59 x 10-8m3kg-1 to 971.27 x 10-8m3kg-1 with an average of 179.83 x 10-8 m3kg-1. The wide range suggests a varied concentration of magnetic minerals in the soils. Soils with high pedogenic magnetic minerals will exhibit high χfd % values. In this study, the χfd % values vary between 0 % and 2.67 % with an average of 0.68 %. The low values suggest the absence of ultra-fine superparamagnetic (SP) grains and that the magnetic signal is largely controlled by the coarse-grained (multi-domain) iron-bearing minerals, which is further corroborated by the S20 (IRM20mT/SIRM) and χARM/SIRM ratios. The average S-ratio value is 0.98, suggesting that these soils have a major proportion of low-coercivity minerals. The strong correlation between χlf and SIRM (r^2 = 0.80) suggests the presence of a high concentration of ferrimagnetic minerals. The low χfd % suggests a low pedogenetic intensity and that the iron-bearing
minerals are largely derived due to the physical weathering of the parent rocks.

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The effect of continentality and elevation on erosion rate in Victoria Land, Antarctica

Ross Whitmore[1], Kevin Norton[2], Cliff Atkins[2], Jamey Stutz[2], Andrew Mackintosh[2]
[1]Monash University, Melbourne, Australia, [2]Victoria University of Wellington, Wellington, New Zealand

The extremely cold and dry conditions present in Antarctica minimize the effect of weathering and erosion on the landscape culminating in some of the lowest erosion rates on Earth (Protenga et al., 2011). Previous Antarctic-wide reanalysis of erosion rates shows that latitude, continentality, and elevation do not play a role in controlling the rate of erosion in Antarctica (Marrero et al., 2018). However, the existing data used for reanalysis are heavily biased toward inland, high-altitude areas near the ice sheet. None are within 20 km of the ocean and very few are at low elevation.

We use terrestrial cosmogenic nuclides to determine the differential erosion rate for graywacke using glacially striated quartz veins. These data were collected at low-elevation sites, near seasonally open water in Northern Victoria Land, Antarctica, away from the dominant climatic influences of the ice sheet and large katabatic corridors which funnel cold, dry, sediment starved air from the Antarctic interior.

Our low-elevation costal rates (8.86±0.78 m/Myr and 7.15±0.06 m/Myr) are the highest measured on the continent, while the values 50 km inland at ~500 m elevation show high to average rates (3.38±0.27 m/Myr and 1.08±0.09 m/Myr) for Antarctic conditions. When these new rates are plotted with other reanalysis data from Victoria Land there is a strong negative correlation between altitude/continentality and erosion rate. The presence of an erosion rate gradient is significant for the study of landscape evolution and also when correcting terrestrial cosmogenic nuclide exposure ages on landforms and bedrock used to constrain glacial histories.

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The First Turkish Antarctic Meteorite Search Expedition

Mehmet Yesiltas[1], Michael Zolensky[2], Burcu Ozsoy[3], Timothy D. Glotch[4]
[1]Kirklareli University, Kirklareli, Turkey, [2]NASA-JSC, Houston, United States of America, [3]Istanbul Technical University, Istanbul, Turkey, [4]Stony Brook University, Stony Brook, United States of America

Meteorite recovery expeditions systematically search various areas in Antarctica to recover meteorites from the bare blue ice fields. For instance, the Japanese Antarctic Research Expedition (JARE) and the Belgian Antarctic Expedition (BELARE) joint expeditions recovered more than 900 meteorites in the 2010-2011 and 2011-2012 seasons within the blue ice fields of Nansen ice field. More recently, a daily reconnaissance trip to the Nansen blue ice fields resulted in the recovery of 3 meteorites by the Turkish Antarctic Expedition. Upon recovery, they were given preliminary identification numbers of 190109286, 190109287, and 190109288. Their weights are 7.52 g, 50.68 g, and 6.24 g, respectively. After classification at NASA's Johnson Space Center, these meteorites were discovered to be L and H type ordinary chondrites. Following their classification, the meteorites were given permanent official names (Asuka 18001, 18002, and 18003) according to the guidelines set by the Nomenclature Committee of the Meteoritical Society. The Turkish Meteorite Working Group has established a protocol to store and curate the recovered meteorites upon request after their necessary preliminary investigations. In this presentation, we will report results of our recent laboratory work in the recovered meteorites as well as the expedition details.

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