ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SWITZERLAND

April 1st, 2019 to March 31st, 2020

New GEOTRACES or GEOTRACES-relevant scientific results

- This was a productive period for Swiss GEOTRACES-relevant research, with a total of 16 publications from Switzerland-affiliated authors (13 first-author papers; see list below).
- Perhaps the most significant Swiss contribution is represented by the first trace metal biogeochemistry publications from the Antarctic Circumnavigation Expedition carried out by the Swiss Polar Institute in early 2017 (https://spi-ace-expedition.ch/). With high spatial resolution in the shallow subsurface, the circumpolar Southern Ocean data allow a detailed analysis of the behaviour of a suite of trace metals relative to macronutrients (Janssen et al., 2020), as well as characterising the stable isotope systematics of the biologically-active trace metals chromium (Rickli et al., 2019), cadmium (Sieber et al., 2019) and zinc (Sieber et al., 2020). The circumpolar sampling of all Southern Ocean zones and co-analysis of cadmium, zinc and their isotopes allowed Sieber et al. (2020) to explain how (a) the extent of biological drawdown in the surface Southern Ocean and (b) its associated isotope fractionation combine to explain the observation that upper-ocean water masses exported from the Southern Ocean (SAMW, AAIW) bear isotopically-fractionated signals for Cd, but not for Zn (see Fig. below).

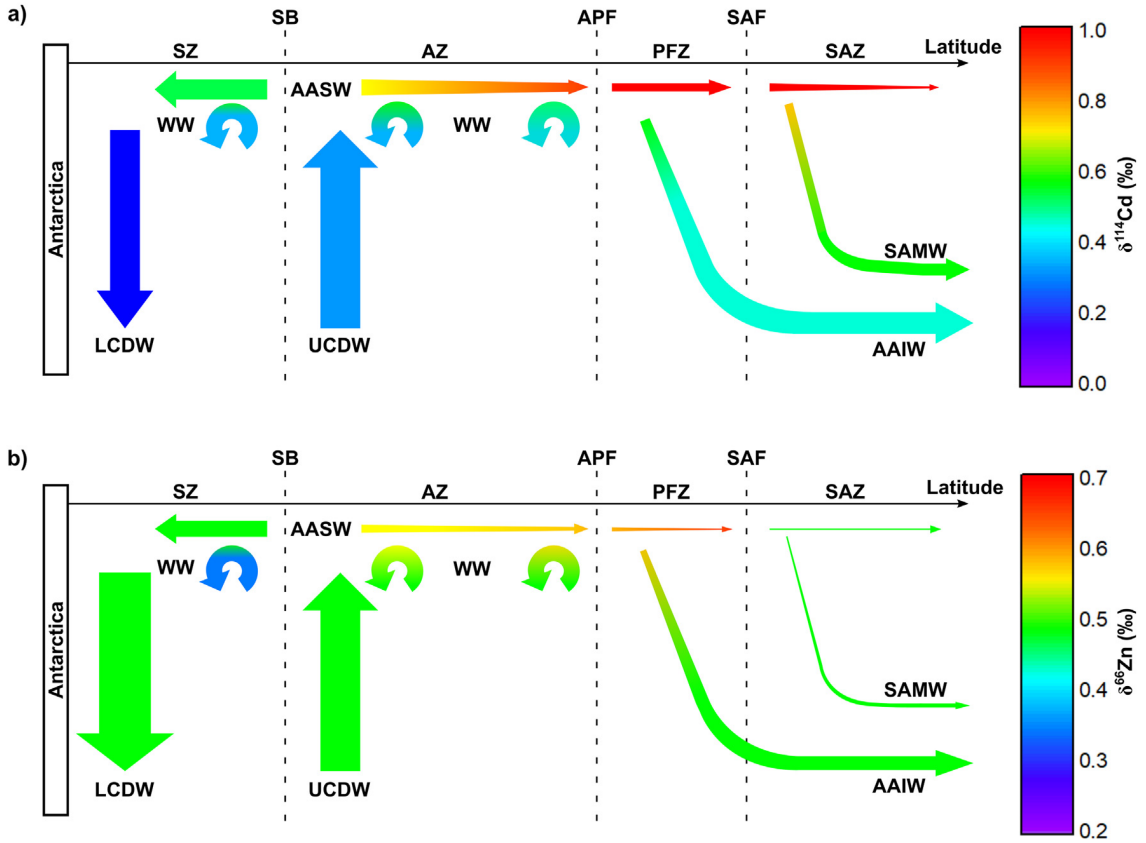

Figure from Sieber et al. (2020): Schematic cycling of (a) Cd and (b) Zn in the upper Southern Ocean. Arrows represent the meridional circulation across the Southern Ocean fronts (dashed lines; SAF: Subantarctic Front; APF: Antarctic Polar Front; SB: Southern Boundary). Arrow thickness represents observed dissolved Cd (range: ~0 to 1 nmol/kg) and Zn concentrations (range: ~0 to 7.5 nmol/kg). Colours indicate dissolved isotope signatures of water masses (SAMW: Subantarctic Mode

Water; AAIW: Antarctic Intermediate Water; AASW: Antarctic Surface Water; WW: Winter Water; UCDW/LCDW: Upper/Lower Circumpolar Deep Water).

New projects and/or funding

- 01.04.2019–31.09.2022: "Using trace metal isotopes to understand ocean biogeochemistry: ancient and modern", Swiss National Science Foundation project funding to Prof. Derek Vance, ETH Zurich.
- 01.01.2020–31.12.2021: "The critical role of sedimentary trace element fluxes in ocean biogeochemistry", ETH Fellowship to Dr. Jianghui Du, ETH Zurich (Group of D. Vance).

New GEOTRACES or GEOTRACES-relevant publications

Researchers at Swiss institutions in ***bold****.*

- **Blanco-Ameijeiras, S.**, **D. Cabanes**, **C. S. Hassler** (2019). Towards the development of a new generation of whole-cell bioreporters to sense iron bioavailability in oceanic systems – learning from the case of *Synechococcus* sp. PCC7002 iron bioreporter. *Journal of Applied Microbiology* **127**, 1291-1304.
- **Cabanes, D. J. E.**, L. Norman, A.R. Bowie, S. Strmečki, **C. S. Hassler** (2019). Electrochemical evaluation of iron-binding ligands along the Australian GEOTRACES southwestern Pacific section (GP13). *Marine Chemistry* **219**, Article 103736.
- **Ciscato, E. R.**, **T. R. R. Bontognali**, S. W. Poulton, **D. Vance** (2019). Copper and its isotopes in organic-rich sediments: from the modern Peru Margin to Archean shales. *Geosciences* **9**, doi: 10.3390/geosciences9080325.
- **Clarkson, M. O.**, **K. Müsing**, M. B. Andersen, **D. Vance** (2019). Examining pelagic carbonate-rich sediments as an archive for authigenic uranium and molybdenum isotopes using reductive cleaning and leaching experiments. *Chemical Geology* **539**, Article 119412.
- Costa, K. M. and 33 co-authors including **S. L. Jaccard** (2020). ^{230}Th normalization: new insights on an essential tool for quantifying sedimentary fluxes in the modern and Quaternary ocean. *Paleoceanography and Paleoclimatology* **35**, e2019PA003820.
- Ellwood, M. J., **C. Hassler**, **S. Moisset**, L. Pascal, **F. Danza**, **S. Peduzzi**, **M. Tonolla**, **D. Vance** (2019). Iron isotope transformations in the meromictic Lake Cadagno. *Geochimica et Cosmochimica Acta* **255**, 205-221.
- **Hassler, C.**, **D. J. E. Cabanes**, **S. Blanco-Ameijeiras**, S. G. Sanders, R. Benner (2019). The role of labile and refractory ligands in the global ocean iron cycle: closing the loop. *Marine and Freshwater Research* **71**, 311-320.
- **Janssen, D. J.**, J. Rickli, P. D. Quay, A. E. White, P. Nasemann, S. L. Jaccard (2020). Biological control of chromium redox and stable isotope composition in the surface ocean. *Global Biogeochemical Cycles* **34**, e2019GB006397.
- **Janssen, D. J.**, **M. Sieber**, M. J. Ellwood, T. M. Conway, P. M. Barrett, X. Chen, **G. F. de Souza**, **C. S. Hassler**, **S. L. Jaccard** (2020). Trace metal and nutrient dynamics across broad biogeochemical gradients in the Indian and Pacific sectors of the Southern Ocean. *Marine Chemistry* **221**, Article 103773.

- **Köbberich, M.**, **D. Vance** (2019). Zn isotope fractionation during uptake into marine phytoplankton: Implications for oceanic zinc isotopes. *Chemical Geology* **523**, 154-161.
- **Lemaitre, N.**, **G. F. de Souza**, **C. Archer**, **R.-M. Wang**, H. Planquette, G. Sarthou, **D. Vance** (2020). Pervasive sources of isotopically light zinc in the North Atlantic Ocean. *Earth and Planetary Science Letters* **539**, Article 116216.
- **Rickli, J. D.**, **D. J. Janssen**, **C. Hassler**, M. J. Ellwood, **S. L. Jaccard** (2019). Chromium biogeochemistry and stable isotope distribution in the Southern Ocean. *Geochimica et Cosmochimica Acta* **262**, 188-206.
- **Sieber, M.**, T. M. Conway, **G. F. de Souza**, **C. S. Hassler**, M. J. Ellwood, **D. Vance** (2020). Cycling of zinc and its isotopes across multiple zones of the Southern Ocean: Insights from the Antarctic Circumnavigation Expedition. *Geochimica et Cosmochimica Acta* **268**, 310-324.
- **Sieber, M.**, T. M. Conway, **G. F. de Souza**, **C. S. Hassler**, M. J. Ellwood, **D. Vance** (2019). High-resolution Cd isotope systematics in multiple zones of the Southern Ocean from the Antarctic Circumnavigation Expedition. *Earth and Planetary Science Letters* **527**, Article 115799.
- **Vance, D.**, **G. F. de Souza**, Y. Zhao, J. T. Cullen, M. C. Lohan (2019). The relationship between zinc, its isotopes, and the major nutrients in the North-East Pacific. *Earth and Planetary Science Letters* **525**, Article 115748.
- Whitby, H., H. Planquette, N. Cassar, E. Bucciarelli, C. L. Osburn, **D. J. Janssen**, J. T. Cullen, A. González, C. Völker, G. Sarthou (2020). A call for refining the role of humic-like substances in the oceanic iron cycle. *Scientific Reports* **10**, doi: 10.1038/s41598-020-62266-7.

Completed GEOTRACES PhD or Master theses

- Matthias Sieber, Ph.D. thesis, ETH Zurich: "The role of the Southern Ocean in the global biogeochemical cycling of cadmium and zinc and their isotopes".
  Supervisors: Prof. D. Vance, Dr. T. Conway, Dr. G. de Souza.
  https://www.research-collection.ethz.ch/handle/20.500.11850/348367

GEOTRACES presentations in international conferences

- **Chatterjee, A.**, **E. R. Ciscato**, S. H. Little, S. Severmann, J. McManus, **D. Vance** (2019). "The output of nickel from the ocean to reducing sediments" , Goldschmidt2019, Barcelona, Spain. *Poster presentation.*
- **de Souza, G. F.**, **M. Sieber**, T. M. Conway, **D. Vance** (2019). "Biogeochemical behaviour of Cd and Zn in eastern-boundary OMZs", Goldschmidt2019, Barcelona, Spain. *Oral presentation.*
- **Eisenring, C. E.**, **G. F. de Souza**, S. P. Khatiwala, **D. Vance** (2019). "Influence of seasonal variability on Zn cycling in OGCMs with different spatial resolutions", Goldschmidt2019, Barcelona, Spain. *Poster presentation.*
- **He, Z.**, **M. O. Clarkson**, M. Andersen, **C. Archer**, F. Huang, **D. Vance** (2019). "Understanding molybdenum and uranium isotope systematics in continental margin sediments", Goldschmidt2019, Barcelona, Spain. *Poster presentation.*
- **Janssen, D. J.**, J. Rickli, P. Quay, A. White, S. L. Jaccard (2019). "Biological control of δ^{53}Cr in the surface ocean", Goldschmidt2019, Barcelona, Spain. *Oral presentation*.

- **Janssen, D. J.**, M. Sieber, M. J. Ellwood, T. M. Conway, P. M. Barrett, C. S. Hassler, S. L. Jaccard (2020). "Significant biological uptake of trace metals in the Mertz Glacier Polynya", Ocean Sciences Meeting 2020, San Diego, USA. *Oral presentation.*
- **Lemaitre, N.**, H. Planquette, F. Dehairs, F. Planchon, G. Sarthou, P. Lherminier, **D. Vance** (2019). "Trace element cycling in the North Atlantic", Goldschmidt2019, Barcelona, Spain. *Keynote oral presentation.*
- **Nasemann, P.**, J. Rickli, P. Grasse, M. Frank, S. L. Jaccard (2019). "Cr reduction and associated isotope fractionation restricted to anoxic shelf waters in the Peruvian Oxygen Minimum Zone", Goldschmidt2019, Barcelona, Spain. *Poster presentation.*
- **Rickli, J.**, D. J. Janssen, C. Hassler, M. J. Ellwood, S. L. Jaccard (2019). "Chromium biogeochemistry and stable isotope distribution in the Southern Ocean", Goldschmidt2019, Barcelona, Spain. *Oral presentation.*
- **Sieber, M.**, T. M. Conway, **G. F. de Souza**, M. J. Ellwood, **D. Vance** (2019). "Iron cycling in the upper Southern Ocean: insights from Fe isotopes", Goldschmidt2019, Barcelona, Spain. *Oral presentation.*
- **Sun, M.**, **C. Archer**, **D. Vance**, Y. Shen (2019). "Improved ion-exchange procedures for multiple transition metal isotope proxy studies", Goldschmidt2019, Barcelona, Spain. *Poster presentation.*

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