

**COST Action 735/801 Workshop on**  
**“Trace Metal speciation: Current state of the art**  
**and towards the construction of a database “**  
**IFM-GEOMAR, Kiel, Germany, 16-17 August 2010**

Workshop Summary and Report

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Meeting Support provided by Dr M Heller and O Baars.

The meeting was attended by 35 people from 14 countries, with 20 of those attending being supported directly by either COST Action 735 or 801. The aim of the meeting was to discuss the current state of the field with respect to measurements of trace metal speciation, identify the current groups working in this field and the current and potential users of this data. The main goal of the meeting was to bring workers in this field together and to develop a common criterion for data analysis and quality control for use in submitting data to a common database. For this purpose we also invited experts in data management to help facilitate this interchange of information. The topic is crucial to our understanding of the role of iron and other trace metals in ocean productivity, not only for the High Nutrient Low Chlorophyll (HNLC) regions which are strongly iron limited, but also in the Tropical oligotrophic gyres where productivity is limited by the availability of fixed nitrogen, and the direct fixation of atmospheric nitrogen by marine organisms may be influenced by metal supply and bioavailability. Furthering our understanding of the speciation of bioactive-elements in the present data ocean is also central to the testing and validating of paleoclimate proxies (e.g. Cadmium).

The organization of this meeting was undertaken as part of the activities of Working Group I (Short-lived trace gas production and biological feedbacks) in Cost Action 735 (Tools for Assessing Global Air–Sea Fluxes of Climate and Air Pollution Relevant Gases) and Working Groups 2 (Intercalibration) and 3 (Data Management) in Cost Action 801 (The Ocean

Chemistry of Bioactive Trace Elements and Paleoclimate Proxies). This meeting would not have been possible without the support of the COST office in Brussels and from the chairs of Action 735 (Prof Peter Liss, UEA) and 801 (Prof Gideon Henderson, Oxford) who helped support this proposal. Gideon Henderson also was helpful for gaining support for this meeting through his role as co-chair of GEOTRACES as was his counterpart at SOLAS (Prof. Douglas Wallace, IFM-GEOMAR). Special thanks goes to Kath Mortimer (COST 735: UEA) and to Sara Tennakoon (COST 801: Oxford) who handled the paperwork connected to this meeting. The meeting could not have taken place without the help of Maeve Lohan (University of Plymouth) and Emilie Breviere (SOLAS IPO, Kiel).

The participants at the meeting were chosen so as to include researchers actively working on trace element speciation and to represent a wide range of different disciplines and approaches to this topic. Unfortunately some invited participants, from Australia, Turkey and Poland, could not attend at the last minute due to family commitments but were keen to participate in the follow up discussions via email to this meeting (see section on outputs later in this report). A number of early career scientists were also able to attend the meeting and took an active part in both the formal and informal discussions. A press release in both German and English was made on the 16<sup>th</sup> of August, and included a group photo of the participants, and was available on the homepage of IFM-GEOMAR later that day. The press release was subsequently used by 11 media organizations the next morning (see appendixes below).

The meeting agenda (see appendix) was constructed around 3 invited talks that outlined the current state of the art and then a series of sessions devoted to key aspects related to constructing a database. All the sessions were designed to enable plenty of debate and to facilitate exchange of information between the participants. Overall there were a number of key issues pertinent to the goals of this meeting and that of a construction of a centralised database that were directly addressed:

- (1) What is the current state of knowledge on trace metal speciation in seawater?
- (2) What techniques are currently employed?
- (3) What historical data is available?
- (4) How should the database be constructed? What are the critical parameters? How should the data quality be assessed?
- (5) What meta data is critical to include (e.g. detection window, competing ligand etc...)
- (6) Prospects for Intercalibration samples/standards (Includes preservation issues).

August 16

Dr Croot (IFM-GEOMAR) gave a short introduction and welcome to the participants of the meeting. Dr Croot stressed the need for the community of trace metal speciation scientists to work together and develop their own criteria for data quality and to ensure that it is easily recoverable, and interpretable, from databases. He then introduced the 3 invited speakers who would make presentations on the current state of the field.

The first invited speaker was Dr Kristen Buck from the Bermuda Institute of Ocean Sciences (BIOS) who gave a presentation entitled “State of the art: Dissolved Fe and Cu speciation in the open ocean”. The main points of her talk are listed below:

- 99% of Fe and Cu in seawater is organically complexed.
- Complexed Fe is apparently to some extent bioavailable, and has a long residence time,
- Complexed Cu less bioavailable, presumably to limit toxicity, though recent research shows that Cu is also important for phytoplankton.
- Method used historically and in the recent GEOTRACES intercalibration:
  - CLE-ACSV with NN, TAC and SA for iron ligands and SA for copper ligands,
- Hardware improvements:
  - Signal to noise ratio
  - Autosampler
  - TM rosette
- Improvements in sensitivity can be driven by:
  - Bigger Hg drops
  - Buffer
- GEOTRACES sections planned
- High resolution studies and process studies (Incubations),
  - Fe ligand conc. went up under Fe limitation during incubation,
  - Cu ligand did show significant difference,
  - Low Fe ligand → high Cu ligands,
- Ligand sources and sinks
  - Atmospheric deposition and *in situ* production
  - Active bio production vs. passive production via degradation of cells

Following her talk there were a number of questions raised in discussion:

- What is the role of colloidal iron? Is this the major source of ligands in the dissolved phase?
- What is the effect of iron limitation on ligand concentrations?
- What is the lifetime of the Fe and Cu complexing ligands and how do they influence deepwater residence times for the elements?

Dr Mak Saito of the Woods Hole Oceanographic Institution (WHOI) gave a very interesting overview of the speciation of Cobalt and Nickel in seawater with his talk entitled “Cobalt and Nickel speciation in the marine environment”. The main point of his talk are summarized below:

- Overview of the current methods employed for Co and Ni:
  - HMDE, CSV, CLE-ACSV,
- Nickel: A fraction is complexed by strong organic ligands.
- Cobalt:
  - labile Co is increasing with depth at the Costa Rica dome (Co depleted surface, probably due to the high concentrations of Cyanobacteria present there).
  - higher labile fraction in the Ross Sea,
- $N_2O$  and Co show linear relationship, possibly due to similar remineralization processes.
- Co(II) much better soluble than Co(III), and almost all Co is Co(II) since Co(III) is much more particle reactive than Fe(III),

There were a number of comments and questions following the talk:

- The equilibration time is crucial to the interpretation of Co(II)/Ni(II) replacement titrations. The slow kinetics of Ni exchange may require days for this replacement to occur.
- Observed cobalt tongue between Africa and South America may be due to release from sediments in the Namibian OMZ.
- What forms of Co is taken up by phytoplankton and bacteria?

The last of the element overview talks was given by Dr Jay Cullen, from Victoria University in Canada, with his presentation entitled “Overview of Cd and Zn speciation in Open Ocean seawater”. The main points of his talk are shown below:

- Total dissolved Zn conc. is much higher in the deep Pacific than in the Atlantic Ocean, both depleted in the surface water.
- The same for Cd, but generally lower concentrations.
- Analytical Methods employed presently:
  - RDE, CLE-ACSV (Zn with APDC), ASV Pseudopolarography
- Limited number of studies reported:
  - Zn (95%) and Cd (70%) are organically complexed,
  - Ligands are in excess in the surface. at depth metal becomes in

Following his talk there was once again a lively exchange of comments and questions, including the following:

- Possible ligand sources for Cd and Zn include molecules with protein like structures.
- Intracellular transport mechanisms for these metals involve chaperones, can these leak out and also fill the same role in the ocean?
- Inorganic speciation is also important here, do we really know this as well as we think we do?

The next phase of the meeting was devoted to the interpretation of speciation data and the discussion was lead by Dr Croot. The main points from this discussion are listed below:

- We should report data in Volumetric units (nmol L<sup>-1</sup>)
- Report both

After the break for lunch and the taking of a group photo, Dr Maeve Lohan from the University of Plymouth, continued the formal part of the meeting with her presentation entitled “Preservation, storage and intercalibration issues”. Dr Lohan mostly discussed results from the recent US GEOTRACES intercalibration cruises where the speciation of Cu and Fe was also included and frozen samples were made available to other international groups:

- Methodology used in the US GEOTRACES intercalibration work at the SAFe station in the Pacific:
  - 0.45  $\mu\text{m}$  filtered seawater (Osmonics – behaves as 0.2  $\mu\text{m}$ )
  - Comparison of fresh samples vs frozen for titrations
  - Tested microwaving samples for 3 x 15 s
  - frozen at  $-20^{\circ}\text{C}$  and  $-80^{\circ}\text{C}$  (in average lower FeL at  $-80^{\circ}\text{C}$ ),
- 1000 m sample:
  - strong variability in samples that were stored in Teflon bottles and then melted during transportation. Customs and logistics issues.
  - Problems with  $\text{CO}_2$  from dry ice lowering the sample pH in transport.
- 3000 m sample:
  - Large variability observed between all laboratories.
  - Sensitivity issues with deep samples?
- Filtration issues appear to be under control
  - Good results found with Acropack capsule (0.2  $\mu\text{m}$ ), Sartobran capsule (0.2 $\mu\text{m}$ ), Osmonics (risk of contamination).

Discussion after Maeve’s talk covered a broad spectrum of issues:

- Problems with 0.4  $\mu\text{m}$  filtration as Archaea are in this size range between 0.2 and 0.4  $\mu\text{m}$ . Most systems used currently have 0.2  $\mu\text{m}$  final filtration.
- Important to recognize limits of fitting methods when the ligands are fully saturated in the samples. No meaningful value of K is obtainable.
- Acid washed bottles must be filled with MQ for at least a week to avoid problems with low pH in samples from residual acid in bottle. May be related to volume of water used for rinsing the sample bottles?
- Proposal for a summer school on Intercalibration and Training exercises for speciation measurements in seawater.
- Possible suggestions for voltammetric speciation standards that did not require freezing or other stability issues:
  - i. UV seawater with known ligand such as DFO-B.
  - ii. KCl with EDTA. (Use of KCl in some labs may be limited due to safety issues).
  - iii.  $\text{CaCl}_2$  with EDTA (Ca more important cation for side reactions with ligands)

The next presentation was by Dr Alessandro Tagliabue (LSCE, Paris, France), with help from Dr Christoph Völker (AWI, Bremerhaven, Germany) who gave their case for the value of an Fe speciation database.

- The numbers of Ligand measurements have increased, and will increase substantially under GEOTRACES, making validation of models for this parameter far easier for modelers.

Despite this being the second last discussion session during a long day of talks, this session provoked a good exchange between the modelers and the experimentalists. The key topics of discussion were as follows:

- Is the relationship between DOC and iron binding ligands robust?
- Can you use humic substances as a model for iron binding ligands in GCMs? Possibly not as humic fluorescence is anti-correlated to ligand distributions in surface waters, may be better as a component for deep water ligand concentrations.
- Redox data important as models currently do not replicate O<sub>2</sub> distributions adequately.
- Model – database feedback important for proposing new study regions or processes and for checking oceanographic consistency of the data.

The final presentation of the day was by Dr Ed Mawji (BODC, United Kingdom) who gave a nice overview of the current and future plans for the GEOTRACES database and how it might apply to the goal of this meeting:

- The GEOTRACES database now includes 14 IPY and 4 section cruises in the database.
- There are over 40.000 parameters in the BODC databases. Have to be aware of legacy issues with regards to the naming of parameters.
- Issue of having to submit to national databases first as requirement of funding. No funding for historical datasets, this has to be done by the community itself.
- If you want an open access database for ligand data

The final discussion session of the day was focused on database issues and was a good opportunity for the scientists present to learn first hand from the experiences of the database managers:

- Authorships rights can be tricky. However there are precedences for publications of data collections where all those who contributed were included as a co-author.
- Metadata is necessary (“It’s all about preservation!”)
- Documentation must be clear: Reporting how the data and metadata were obtained.
- We need to learn from the business world – they have been archiving material for decades.
- Helps to have similar data in the same format. Develop a standard template within this community for use with scientific databases. This can be done through the new Wiki (see below).

*August 17*

*Identifying the tasks ahead*

The participants were given a short presentation by Dirk Fleischer and Pina Springer from the IFM-GEOMAR on different databases and the establishment of a Wiki for Trace Metal Speciation in Seawater. The main German database, PANGAEA, was introduced by Dirk and he showed us some examples of data already existing in that database. It was also stressed that the inclusion of specific keywords would also help in data mining for speciation related work. He also stressed the importance of data quality flags and quality control as this was best assessed by the data providers and not the data managers or end users. Pina Springer then introduced the participants to the newly created Trace Metal Speciation in Seawater Wiki page that had been set up that morning. The development of this Wiki will help facilitate further discussion of the issues raised at this meeting and with a wider audience of scientists.

The final session of the meeting was a group discussion chaired by Dr Croot which covered all the topics raised during the meeting. This session led to the creation of a list of final products and outcomes of the meeting:

**Products and outcomes**

- An article summarizing the results of the meeting for submission to EOS.
- Establishment of a Wiki for the exchange of information on trace metal speciation theory and techniques. This Wiki is already functioning (<https://portal.ifm-geomar.de/web/tmsis/wiki>) and is being constantly updated. People interested in participating in this wiki should contact Dr Peter Croot for more information ([pecr@pml.ac.uk](mailto:pecr@pml.ac.uk)).
- That the Wiki should also form as the initial repository for historical speciation data currently not available in online databases.
- Templates for the format of speciation data to be submitted to national and international databases will be made available on the Wiki for comment before a final recommendation is made within the next year.

- The Wiki will also include database links and bibliographies of published works on trace metal speciation in seawater.
- Student exchanges between laboratories via COST Action 801 STSM should be encouraged. For exchanges where COST funds cannot be used, alternative funding sources should be explored.
- Explore and develop a proposal for a research school for trace metal speciation. These efforts would complement existing plans within GEOTRACES for shipboard intercalibrations for trace metal speciation.
- Examine the possibility of an ESF meeting/workshop to be held in 2 years time on the subject of trace metal speciation and bioavailability.

Appendix I – Participant List:

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Appendix II: Workshop Agenda

**Monday Aug 16**

- 08:30 *Welcome and general introduction* **P Croot**
- 08:45 *Discussion - What is the current state of knowledge on trace metal speciation in seawater?*
- 08:45-09:15 *Fe and Cu speciation in the open ocean.* **K Buck (Invited)**
- 09:15-09:45 *Co and Ni speciation in the open ocean.* **M Saito (Invited)**
- 09:45-10:15 *Zn and Cd speciation in the open ocean.* **J Cullen (Invited)**
- 10:30 Coffee Break – Informal Discussions
- 11:00 *Discussion – Interpretation of Speciation Data*
- 11:00-12:30 – *Model fitting as meta-data and other issues* **Open**
- 12:30 Lunch – Informal Discussions (12:15-12:30 Group Photo Foyer)
- 13:30 *Discussion – Quality control of speciation data*
- 13:30 – 13:45 – *Preservation, Storage and Intercalibration issues* **M Lohan**
- 15:00 Coffee Break – Informal Discussions
- 15:30 *Discussion – What do modellers want from a database?* **A Tagliabue & C Volker**
- 16:00 *Discussion – How do you construct a database?*
- 16:00 – 16:15 – *The GEOTRACES database* **E Mawji**
- 19:30 Group Dinner – Louf (Kielinie)

**Tuesday Aug 17**

- 08:30 *Open Discussion – Identifying the tasks ahead*
- 09:00-09:15 – *Other Databases and the TSMIS Wiki* **D Fleischer & P Springer**
- 10:00 Coffee Break – Informal Discussions
- 11:00 *Final Synthesis and Recommendations for Future work*

Appendix III: Press Release August 16, 2010



**Participants at the COST 735/801 Meeting in Kiel, Aug 16-17, 2010 (Photo: A Villwock).**

## **Salz in der Suppe: Spurenmetalle im Ozean**

### **– Internationales Expertentreffen am IFM-GEOMAR –**

*16.08.2010/Kiel.* Meerwasser enthält nicht nur Salz, sondern auch verschiedenste Spurenmetalle in geringen Konzentrationen. Diese Spurenmetalle sind für das Wachstum vieler Lebewesen im Meer sehr wichtig. In einem zweitägigen internationalen Expertentreffen, das vom 16.-17. August am Leibniz-Institut für Meereswissenschaften (IFM-GEOMAR) in Kiel stattfindet, diskutieren 30 Wissenschaftler aus 14 Ländern über Fortschritte in Messverfahren und aktuelle Forschungsergebnisse.

Bei Kobalt denkt zunächst kaum jemand an Meerwasser, auch Eisen oder Kupfer verbindet man eigentlich nicht mit dem nassen Element. Dennoch sind diese Metalle in geringen Spuren auch im Meerwasser enthalten und spielen eine sehr wichtige Rolle für das Wachstum mariner Organismen. Kobalt ist zum Beispiel in geringsten Konzentrationen im Meerwasser enthalten, typische Mengen sind 30-70 Picomol pro kg Meerwasser. Das ist unvorstellbar wenig, Natrium beispielsweise, ein Bestandteil des Meersalzes ist mit 0.47 Mol pro Kilogramm  $5 \times 10^{11}$  - Mal so häufig.

„Solche in äußerst geringen Konzentrationen vorkommenden Spurenmetalle im Meerwasser nachzuweisen, ist schon eine besondere Herausforderung“, meint der Meereschemiker Dr. Peter Croot vom IFM-GEOMAR. Deshalb werden die Messverfahren und analytischen Nachweismethoden ständig verbessert.

Dennoch sind diese in geringsten Konzentration auftretenden Spurenmetalle eminent wichtig, Kobalt findet sich beispielsweise in dem lebenswichtigen Vitamin B12 wieder, das viele Pflanzen und Tiere benötigen. Viele Wechselwirkungen zwischen Spurenmetallen und organischen Verbindungen sind bisher unzureichend bekannt und können durch verbesserte Messtechnik erst jetzt überhaupt nachgewiesen und untersucht werden.

„Es wird noch eine Weile dauern, bis wir die Bedeutung der verschiedenen Spurenmetalle in der „chemischen Suppe“ Meerwasser verstanden haben“, so Peter Croot. Der Austausch der neusten wissenschaftlichen Erkenntnisse und Messverfahren, hilft uns sehr, um die Forschung auf diesem Gebiet weiter voranzubringen“, resümiert Croot.

### **Hintergrund:**

Die Veranstaltung am IFM-GEOMAR, an der 30 Experten aus 14 Ländern teilnehmen wird von der Europäischen Union im Rahmen der beiden Programme: EU COST Actions: 735 (Tools for Assessing Global Air-Sea Fluxes of Climate and Air Pollution Relevant Gases) und 801 (The ocean chemistry of bioactive trace elements and paleoclimate proxies) gefördert. Ferner wird das Treffen auch aktiv durch zwei internationale Forschungsprogramme unterstützt: Die Surface Ocean – Lower Atmosphere Study (SOLAS) und das GEOTRACES Programm.

## **Salt for the Soup: Trace metals in the Ocean**

**– International Experts meet at IFM-GEOMAR –**

*August 16, 2010/Kiel.* Sea water not only contains salt but also different trace metals in small concentrations. These trace metals are very important for the growth of different life forms in the ocean. During a two-day meeting (August 16-17) at the Leibniz Institute of Marine Sciences (IFM-GEOMAR) in Kiel, Germany 30 experts from 14 countries discuss progress in measurement techniques and actual research results.

Only a few people would imagine a relationship between sea water and cobalt, iron or copper. Nevertheless sea water contains all these metals in small concentrations. In the ocean they play a very important role for the growth of marine organisms. The cobalt concentration in sea water is very low, with typical values of 30-70 picomolar in seawater (1 picomolar is  $1 \times 10^{-12}$  moles per kg of seawater, for comparison, sodium is present in seawater at 0.47 molar or nearly  $5 \times 10^{11}$  times more than Cobalt).

“To measure such very low concentrations of trace metals in sea water is a special challenge”, explains Dr. Peter Croot from IFM-GEOMAR. Therefore measurements techniques and analytical methods are being steadily improved.

Nevertheless these trace metals in very low concentration are essential, for instance a small fraction of the Cobalt in seawater is found as the essential vitamin B12, an example of a metal-organic complex, which is required for growth by many plants and animals.

Many of these metal-organic complexes are presently unknown to science and their concentrations and properties can only be assessed via comparison of their reactivity with other known complexes. Such information however is important for understanding how these elements are taken up by oceanic organisms and ultimately how they influence the biogeochemical cycling of these elements in the ocean. “Unlocking the chemical secrets contained in seawater will take some time but meetings like this one will help this process along”, says Peter Croot.

### **Background**

This is a joint meeting funded by the European Union through two separate EU COST Actions: 735 (Tools for Assessing Global Air-Sea Fluxes of Climate and Air Pollution Relevant Gases) and 801 (The ocean chemistry of bioactive trace elements and paleoclimate proxies). This meeting has also been actively supported by two large international research programs: SOLAS and GEOTRACES. IFM-GEOMAR scientists are actively involved in both international programs; IFM-GEOMAR researchers have taken part in 3 GEOTRACES related cruises, all in part supported by funding from the DFG. The BMBF Verbundprojekt SOPRAN is the German contribution to SOLAS. The current chair of international SOLAS is Prof. Douglas Wallace of the Chemical Oceanography department at IFM-GEOMAR. The SOLAS International Project Office (IPO) is currently based at the IFM-GEOMAR in Kiel and helped to coordinate this meeting.

## Appendix IV: List of Press organizations using the press release

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### [Wissenschaftler suchen Kobalt im Meerwasser](#)

dpa | 2010-08-16 | Circulation:

...4 Ländern seit Montag am **Leibniz-Institut für Meereswissenschaften** in Kiel. Es sei eine besondere Herausforderung, die Spurenmetalle nachzuweisen, sagte Meereschemiker Peter Croot. Kobalt beispielsweise finde sich im Vitamin B12 wieder, das Pflanzen und Tiere brauchten. Viele solcher Wechselwirkungen...

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### [Wissenschaftler suchen Kobalt im Meerwasser](#)

Wedel Schullauer Tageblatt | 2010-08-16 | Visits (x1000): n/a

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### [Wissenschaftler suchen Kobalt im Meerwasser](#)

Schnefelder Tageblatt | 2010-08-16 | Visits (x1000): n/a

...4 Ländern seit Montag am **Leibniz-Institut für Meereswissenschaften** in Kiel. Es sei eine besondere Herausforderung, die Spurenmetalle nachzuweisen, sagte Meereschemiker Peter Croot. Kobalt beispielsweise finde sich im Vitamin B12 wieder, das Pflanzen und Tiere brauchten. Viele solcher Wechselwirkungen...

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### [Wissenschaftler suchen Kobalt im Meerwasser](#)

Pinneberger Tageblatt | 2010-08-16 | Visits (x1000): 106

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### [Wissenschaftler suchen Kobalt im Meerwasser](#)

Barmstedter Zeitung | 2010-08-16 | Visits (x1000): 116

...4 Ländern seit Montag am **Leibniz-Institut für Meereswissenschaften** in Kiel. Es sei eine besondere Herausforderung, die Spurenmetalle nachzuweisen, sagte Meereschemiker Peter Croot. Kobalt beispielsweise finde sich im Vitamin B12 wieder, das Pflanzen und Tiere brauchten. Viele solcher Wechselwirkungen...

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### [Wissenschaftler suchen Kobalt im Meerwasser](#)

Quickborner Tageblatt | 2010-08-16 | Visits (x1000): 116

...4 Ländern seit Montag am **Leibniz-Institut für Meereswissenschaften** in Kiel. Es sei eine besondere Herausforderung, die Spurenmetalle nachzuweisen, sagte Meereschemiker Peter Croot. Kobalt beispielsweise finde sich im Vitamin B12 wieder, das Pflanzen und Tiere brauchten. Viele solcher Wechselwirkungen...

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## [Wissenschaftler suchen Kobalt im Meerwasser](#)

[shz.de](#) | 2010-08-16 | Visits (x1000): 843

...4 Ländern seit Montag am **Leibniz-Institut für Meereswissenschaften** in Kiel. Es sei eine besondere Herausforderung, die Spurenmetalle nachzuweisen, sagte Meereschemiker Peter Croot. Kobalt beispielsweise finde sich im Vitamin B12 wieder, das Pflanzen und Tiere brauchten. Viele solcher Wechselwirkungen...

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## [Wissenschaftler suchen Kobalt im Meerwasser](#)

WELT ONLINE | 2010-08-16 | Visits (x1000): 30381

...4 Ländern seit Montag am **Leibniz-Institut für Meereswissenschaften** in Kiel. Es sei eine besondere Herausforderung, die Spurenmetalle nachzuweisen, sagte Meereschemiker Peter Croot. Kobalt beispielsweise finde sich im Vitamin B12 wieder, das Pflanzen und Tiere brauchten. Viele solcher Wechselwirkungen...

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## [Wissenschaftler suchen Kobalt im Meerwasser](#)

Kieler Nachrichten | 2010-08-16 | Visits (x1000): 638

...4 Ländern seit Montag am **Leibniz-Institut für Meereswissenschaften** in Kiel. Es sei eine besondere Herausforderung, die Spurenmetalle nachzuweisen, sagte Meereschemiker Peter Croot. Kobalt beispielsweise finde sich im Vitamin B12 wieder, das Pflanzen und Tiere brauchten. Viele solcher Wechselwirkungen...

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## [Wissenschaftler suchen Kobalt im Meerwasser](#)

Lübecker Nachrichten | 2010-08-16 | Visits (x1000): 713

...4 Ländern seit Montag am **Leibniz-Institut für Meereswissenschaften** in Kiel. Es sei eine besondere Herausforderung, die Spurenmetalle nachzuweisen, sagte Meereschemiker Peter Croot. Kobalt beispielsweise finde sich im Vitamin B12 wieder, das Pflanzen und Tiere brauchten. Viele solcher Wechselwirkungen...

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## [Wie kommt das Salz ins Meer?](#)

Schleswig-Holsteinische Landeszeitung | 2010-08-17 | Pageimpressions: n/a

...**Leibniz-Institut für Meereswissenschaften** in Kiel. Die Summe der beförderten Salze sorgt für einen erheblichen Anstieg der Konzentration. Was wenige wissen: "Der Salzgehalt unserer Meere und die Temperaturen der jeweiligen Gefilde dienen als Motor für unsere Meeresströmungen", betont der ...