URL: http://www.oasdpo.bnl.gov.mosaic/globec

OS42D MC: 124 Thursday 1330h

Calibration and Validation Efforts Under Way by the Ocean Color Missions I *(joint with B)*

Presiding: **G S Fargion,** NASA / Goddard Space Flight Center**; C R McClain,** NASA / Goddard Space Flight Center

OS42D-01 1330h INVITED

Overview of Ocean Color Calibration and Validation Efforts

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Presently, there are six ocean color missions (SeaWiFS, MODIS, OSMI, MOS, OCI, and OCM) on orbit, with MERIS and MODIS/Aqua and GLI soon to be launched. The US community, under the NASA SIMBIOS program, as well as the international community, are undertaking substantial research efforts in calibration and validation activities, which span in situ bio-optical and atmospheric data collections, algorithm refinement and development, calibration and data analysis round-robins,and data merging activities to produce long term ocean color data sets.

This paper will overview the ongoing ocean color remote sensing calibration and validation activities. To date, measurements by OCTS, POLDER, OSMI and SeaWiFS have been compared with the MOBY to provide a uniform set of ocean color measurements at a single site. In addition, SeaBASS is used by SIMBIOS to provide a set of in situ (field collected) water leaving radiance and chlorophyll-a measurements for the validation of satellite ocean color measurements at locations away from the MOBY site. SeaBASS and the AERONET archive also include an extensive set of in situ measured aerosol optical thickness and other atmospheric parameters to provide a basis for examining and improving current atmospheric correction algorithms. The presentation will review the SIMBIOS program activities, the status of the ocean color missions, and future plans.

URL: http://simbios.gsfc.nasa.gov

OS42D-02 1345h INVITED

Stray Light Characterization for MOBY

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The Marine Optical System (MOS) is used as a down-welling irradiance and up-welling in-water radiance profiler in two configurations: as the sensor for the Marine Optical Buoy (MOBY) and as a mobile, shipboard-deployable sensor. Both systems are used for vicarious calibration of satellite ocean color sensors, e.g. MODIS, SeaWiFS, OCTS, POLDER, and IRS1-MOS. Ocean color, instrument specific, band-averaged normalized water-leaving radiances, nL_W's, are reported by the MOBY team, corresponding to data sets from MOBY at the Lanai, Hawaii site and various cruise stations for the MOS profiler. For the vicarious calibration of MODIS and SeaWiFS, total band-averaged nL_W's are required for the spectral range from 412 nm to 670 nm.

Stray light in the MOS spectrographs affects the radiometry in a complicated manner that depends upon the relative spectral shape of the measured fluxes and the spectral region of interest. Here we report on the results of a detailed radiometric characterization of the MOS and MOBY configurations. In this work, a rigorous study of the MOS profiler was performed using broadly tunable, narrow-band lasers at the NIST facility for Spectral Irradiance and Radiance Responsivity Calibrations using Uniform Sources (SIRCUS). These measurements enabled an accurate determination of the stray light contribution to the measured signals from MOS. A stray light correction algorithm was developed and assessed using MOS measurements of a laboratory standard of spectral radiance. In a second phase of the study, a mobile tunable laser system was developed and deployed at the MOBY field support site in Honolulu, Hawaii, and MOBY (MOBY218) was characterized for stray light performance.

The stray light characterization procedures and the preliminary results are presented. The correction algorithm was applied to MOS profiler system responses and test data sets from the fifth Marine Optical Characterization Experiment (MOCE-5) cruise. Additionally, the algorithm was applied to MOS data sets for a series of laboratory color-filtered sources of known spectral radiance. The initial tests on MOCE-5 stations demonstrate that the stray light effect on the upwelling spectral radiance, $L_u(z, \lambda)$ is less than 5 % at 412 nm and smaller at other ocean color bands. The characterizations on MOBY218 concentrated on the radiance input optic that is coupled directly to the MOS, as well as the top and middle arms, which are coupled to MOS using optical fibers. Improved values of $L_u(z, \lambda)$, with lower uncertainty, will be determined for all MOBY data sets. These results impact the calibrations of all ocean color satellites that use MOBY and MOS data sets and will provide more accurate values of the retrieved nL_Ws, spectral radiance attenuation coefficients and bio-optical products, i.e. pigment concentrations.

URL: http://www.mlml.calstate.edu/groups/physoce/physoce.htm

OS42D-03 1405h INVITED

Expected Improvements in Atmospheric Correction of Ocean Color Imagery Over Case 1 Waters

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Atmospheric correction is a crucial and difficult step in the processing of ocean color satellite imagery because of the high variability in space and time of the concentrations in small particles in the atmosphere. Interestingly, the basic principle for atmospheric correction has not changed since the proof-of-concept CZCS in the late 70's. Even for the most recent and high-performance ocean color such as MODIS and MERIS, the aerosol contribution is estimated from the near-infrared (NIR) and is then extrapolated toward the visible to correct the measured radiances. This technique has two major drawbacks: (1) Errors in aerosol characterization in the NIR are amplified once propagated in the blue-green; (2) This technique is not capable of distinguishing between weakly and strongly absorbing aerosols because aerosol absorption is much more efficient in the blue-green than in the NIR.

An alternative approach for atmospheric correction is to use a model of the water- leaving radiance together with a model of the aerosol radiance to determine which set of aerosol (optical depth, single scattering albedo...) and marine (chlorophyll, CDOM...) parameters leads to the best match between computed and measured radiances over the whole (visible + NIR) spectrum. Two different techniques were developed: the Spectral Optimization Algorithm (SOA) and the Spectral Matching Algorithm (SMA). Both algorithms were tested with SEAWIFS imagery and were shown to strongly improve ocean color estimates for case 1 waters in the presence of pollution aerosols (SOA) and Saharan dust (SMA). Such algorithms should also be applicable to case 2 waters provided that accurate models of the water-leaving radiance are available.

These algorithms however require a good knowledge on the aerosol properties. It is likely that future atmospheric corrections will not be "universal" anymore and will use different aerosol data set depending on the oceanic region observed by the sensor. Another difficulty in using both SOA and SMA is that they require much more computer time than the standard atmospheric correction. The use of advanced programming techniques based, for example, on neural networks is now attempted to speed up the processing. Improved aerosol models and more efficient computations are certainly the key parameters toward a new generation of operational atmospheric correction algorithms.

OS42D-04 1425h INVITED

A Review of Bio-Optical Chlorophyll Algorithms and Future Challenges

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The highly successful bio-optical algorithm used in the global processing of CZCS was empirically derived by statistically relating fewer than 60 in situ observations of water-leaving radiance band ratios to phytoplankton pigment concentration. Since then, improvements in empirical algorithms have mostly resulted from the increased quantity, quality and variety of in situ Rrs-chlorophyll data sets acquired during the past decade from many diverse bio-optical provinces of the global ocean. Concurrent improvement in the knowledge of bio-optical principles has resulted in the emergence of more analytic model-based algorithms for estimating chlorophyll and other water constituents. The relative strengths and weaknesses of the various types of algorithms are discussed. Some of the present and near future challenges are also presented: the need for high quality IOP data, the compatibility between regional and global algorithms, the coupling of atmospheric and in-water models, and the integration of data from a variety of ocean color sensors into a complete picture of the distribution of chlorophyll over the global ocean.

OS42D-05 1505h

Reprocessing of the OCTS Global Dataset, a Collaborative Effort Between NASDA and the NASA SIMBIOS Project

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As a payload on the ADEOS spacecraft, the Ocean Color and Temperature Scanner (OCTS) was launched and operated by the National Space Development Agency (NASDA) of Japan in August of 1996. The OCTS instrument began routine imaging in November of 1996, making it the first operational mission

dedicated to the acquisition and monitoring of oceanic chlorophyll concentration on a global scale. Although the ADEOS spacecraft suffered a catastrophic failure less than eleven months after launch, the data collected during the OCTS mission lifetime is of great value to the Earth science community, as it can provide important information on the baseline state of the worlds oceans prior to the El Nino event of 1997-1998.

The second global ocean color mission to be launched was the Sea-viewing Wide Field-of-view Sensor (SeaWiFS), which has been collecting global data continuously since September of 1997. The unfortunate gap between the end of OCTS operations and the start of SeaWiFS operations makes direct sensor to sensor comparisons impossible, thus leaving considerable uncertainty in any effort to extend the SeaWiFS global ocean color timeseries back to the pre-1997 El Nino period, or to study the propagation of Kelvin and Rossby waves associated with the transition into El Nino. This uncertainty can result from relative differences in instrument calibrations, as well as differences in the atmospheric correction and bio-optical algorithms employed.

The focus of the present work is to minimize the potential differences in the atmospheric correction and bio-optical algorithms between the two sensors, by reprocessing the entire OCTS GAC mission archive using the same software and algorithms employed for standard SeaWiFS processing. The data processing stream will be presented, and OCTS-specific modifications to the algorithms will be discussed. Statistical comparisons between OCTS and SeaWiFS will be shown, and remaining processing issues will be highlighted. Finally, the OCTS product list and data distribution procedures will be provided.

URL: http://simbios.gsfc.nasa.gov/

OS42D-06 1520h

A Comparison Study of the Ocean Color Data Derived from OCTS and POLDER

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We describe our efforts in studying and comparing the ocean color data derived from the Japanese Ocean Color and Temperature Scanner (OCTS) and the French Polarization and Directionality of the Earths Reflectances (POLDER). OCTS and POLDER were both on board Japans Sun-synchronous Advanced Earth Observing Satellite (ADEOS) from August 1996 to June 1997, collecting about 10 months of global ocean color data. This provides a unique opportunity for developing methods and strategies for the merging of ocean color data from multiple ocean color sensors. In this presentation, we describe our approach in developing consistent data processing algorithms for both OCTS and POLDER and using a common in situ data set to vicariously calibrate the two sensors. Therefore, the OCTS and POLDER-measured radiances are effectively bridged through common in situ measurements. With this approach in processing data from two different sensors, the only differences in the derived products from OCTS and POLDER are the differences inherited from the instrument characteristics. Results show that there are no obvious bias differences between the OCTS and POLDER-derived ocean color products, whereas the differences due to noise, which stem from variations in sensor characteristics, are difficult to correct. It is possible, however, to reduce noise differences with some data averaging schemes. The ocean color data from OCTS and POLDER can therefore be compared and merged in the sense that there is no significant bias between two.

OS42D-07 1535h

Recent improvements in POLDER-2 Ocean Color processing

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The POLDER-2 (POLarization and Directionality of the Earth Reflectance) aboard ADEOS-II (scheduled in february 2002) will deliver data five years after POLDER-1 on ADEOS-I (november 1996 june 1997). The two instruments are identical but lots of improvements have been achieved on atmospheric correction and bio-optical algorithms. Those developments should bring new and original global ocean color dataset for end-users.

A new approach, based on the directional capability of POLDER, has been developed to deal with absorption by aerosols. It relies on the change of absorption efficiency with molecular scattering and air mass changes at short wavelength (443 nm). Radiative transfer simulations show that quantitative parameters of both absorption (single scattering albedo) and altitude of the aerosol layer can be derived with enough accuracy to strongly improve the quality of retrieved water-leaving radiances. This aerosol absorption indicator is validated by comparison with the TOMS Aerosol Index. Preliminary results using POLDER-1 data show the improvement in terms of water-leaving radiances when absorbing aerosols are in the atmosphere.

We also developed a new approach for atmospheric corrections above eutrophic and case-2 waters. To do so, we used an additional band (565 nm) to perform the atmospheric correction. the retrieved water-leaving radiance at 565 nm is then used to estimate the water-leaving radiance at 670 nm following a statistical linear relationship. We will present the first results obtained by applying this algorithm to SeaWiFS data above strait of Dover. The retrieved water-leaving radiances were compared with in situ measurements performed with the SIMBADA radiometer.

Besides chlorophyll-a concentration, the two major Inherent Optical Properties, the absorption and backscattering coefficients, will also be provided as standard POLDER-2 bio-optical parameters. The bio-optical algorithm developed for POLDER-2 is based on radiative transfer simulation in seawater (Loisel and Stramski, 2000). We applied it to SeaWiFS data and compared with in situ data from the seaBASS dataset.

OS42D-08 1550h

The OSMI Post-launch Calibration

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The ocean scanning multispectral imager (OSMI) is designed to observe the global ocean color in support of biological oceanography. Since the successful launch of OSMI aboard the KOrea Multi-Purpose SATellite (KOMPSAT) on December 21, 1999, it has been collecting the global ocean color data in the six visible spectral bands centered at 412, 443, 490, 555, 765, and 865 nm. The level-1A data collection over worldwide oceans amounts to about 1.2 terabytes as of August 2001.

The processing of level-1A data needs the radiometric calibration, which converts the measured digital number (DN) to the top of the atmosphere (TOA) radiance, for the calculation of geophysical variables of level-2 products (e.g., chlorophyll concentration). By means of conventional methods for radiometric calibration, we have used the pre-launch laboratory measurements and the onboard solar calibration data, respectively. Both methods, however, were not successful to produce the level-2 products because of the anomalous TOA radiance values of OSMI at shorter wavelengths. We have also attempted an alternative approach using the collocated match-ups of OSMI DNs and SeaWiFS radiances. Results are somewhat encouraging in that this method overcomes the above two methods but still poses difficulties and problems. Currently, the Korea Aerospace Research Institute (KARI) collaborates with the National Aeronautics and Space Administration (NASA) for the activities of ocean color data merger through the SIMBIOS project. As part of such activities, the cross-calibration between OSMI and SeaWiFS is underway to ensure the OSMI data quality. In this presentation, we summarize the OSMI calibration results obtained from the aforementioned methods and compare them with the TOA radiances derived from shipboard measurements made in the East/Japan Sea.

OS42D-09 1605h

A Comparative Study and Intercalibration Between OSMI and SeaWiFS

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Since 1996, following in the success of CZCS, a fleet of space-borne sensors with global ocean color capability have been put into operation by various research institutions throughout the world. The NASA SIMBIOS Project has been funded to evaluate the consistency of oceanic optical properties retrieved by these various missions, with the ultimate goal of merging data from multiple missions to enhance temporal, spectral, or spatial resolution of the global dataset. The work presented here is a collaborative effort between the Korea Aerospace Research Institute (KARI) and the SIMBIOS Project to compare and improve the consistency between two such missions: the Ocean Scanning Multispectral Imager (OSMI) operated by KARI, and the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) operated by NASA and the OrbImage Corporation.

SeaWiFS was launched on 1 August 1997 into a 705-km sun-synchronous polar orbit with a descending equatorial crossing time near local noon. The instrument is a scanning filter radiometer collecting data in eight spectral channels between 400 and 900 nm, with a surface resolution at nadir of approximately 1-km and a swath width of 2800 km.

OSMI is a whisk-broom scanning Charge Coupled Device (CCD) with 96 detectors oriented along track and six programmable spectral channels in the 400 to 900 nm range. The instrument has a ground resolution of approximately 1 km, with a swath width of 800 km. OSMI was launched on 21 December 1999 into a 685 km sun-synchronous polar orbit with an ascending equatorial crossing near 10:50 a.m. local time.

Using the pre-launch calibration and standard atmospheric correction software developed for OSMI, it was found that the sensor was not able to retrieve reasonable ocean optical properties. To allow for meaningful comparisons between OSMI and SeaWiFS, it was necessary to first modify the standard SeaWiFS atmospheric correction software to accept and process the OSMI data, thereby ensuring consistent and proven algorithms. The SeaWiFS normalized water-leaving radiance measurements were then used as truth data to enable a vicarious calibration of the 96 independent CCD elements of each OSMI spectral band. The results of this cross-calibration will be presented, and remaining difficulties will be discussed.

URL: http://simbios.gsfc.nasa.gov/

OS42D-10 1620h

Calibration of MODIS Sea Surface Temperature and Ocean Color Data

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Terra's Moderate Resolution Imaging Spectroradiometer (MODIS) provides the ocean science community with global 1 km-resolution data from both the infrared and visible parts of the radiometric spectrum. The calibration of the MODIS instrument has been complicated by the instrument's sophisticated design, including multiple along-track detectors and a cross-track double-sided paddlewheel mirror assembly. Given the extreme sensitivity of the ocean products to measurement uncertainties, it was necessary to use Earth-view data to develop specific corrections to the radiometric data to establish their calibration.

MODIS provides SST estimates from measurements from 3 medium-wavelength infrared (MWIR: 3.7, 3.9,

and 4.0 μm) and 2 long-wavelength infrared bands (LWIR: 11 and 12 μm). Ten individual detectors in each band provide the along-track resolution; these detectors must be in good relative calibration to prevent striping in the SST estimates. The brightness temperatures in each bank of detectors were statistically normalized to that of a central detector in the series. Since the 2 sides of the paddlewheel mirror assembly are slightly different, it was necessary to apply an offset to the brightness temperatures collected from one side to prevent banding in the SST imagery. Comparisons were then made between a reference SST and the remotely-sensed MWIR and LWIR SSTs. Thus, rather than producing absolute calibrations for each individual MWIR and LWIR band, SST calibration was achieved through the empirical derivation of new coefficients for both SST algorithms. The reference SSTs used for these calibrations were collected by the shipborne Marine-Atmosphere Emitted Radiance Interferometer (MAERI) [Minnett et al., 2001].

The MODIS ocean color products are derived from the measurements of radiance at 9 visible wavelengths: 412, 443, 488, 531, 551, 667, 678, 748, and 868 nm. As with the IR bands, these radiances were also derived from measurements from ten individual detectors per band, and required the same inter-detector statistical normalization procedure to establish good relative calibration. However, the mirror side correction was not as straightforward as with the IR bands. Not only do the mirror sides reflectivities differ, they do so spectrally, and with changing angle of incidence. Therefore, multiple corrections to the total radiance (Lt) were derived statistically from the normalized water-leaving radiance (nLw) for each band that would account for the differences of each mirror side and their nonlinear variation across the scan. The use of the nLw values to derive these corrections to the Lt fields was necessary to provide the level of precision necessary for these calculations. Once the proper polarization was ascertained, the internally consistent normalized water-leaving radiance from each visible band was compared to the in situ values of nLw that were collected by the Marine Optical Buoy (MOBY) and the Marine Optical Characterization Experiment (MOCE) cruises [Clark et al. 2001]. The collection MOBY and MOCE values of nLw were used to set the absolute calibration of each of the 412-678 nm bands. In addition, these in situ data allowed a residual cross-scan trend in MODIS nLw to be eliminated.

These efforts produced SST and ocean color fields with enhanced accuracy and few instrument artifacts. Due to the nature of the electronics on the Terra spacecraft, this calibration procedure must be repeated following significant changes to the on-board electronics configuration.

URL: http://modis-ocean.gsfc.nasa.gov/

OS42D-11 1635h

A Global Climatology of Phytoplankton Pigment Concentration

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Satellite ocean color imagery and in-situ measurements are combined to generate a monthly climatology of phytoplankton pigment concentration over the global oceans at 0.09 degree resolution. The climatology includes data from CZCS (Nov 78 - Jun 86), POLDER and OCTS (Nov 96 - Jun 97), SeaWiFS (Sep 97 - Aug 01), and the SeaBASS archive (Mar 61 - Aug 01). The satellite data sets are individually calibrated against in situ measurements. The various time-series data, satellite and in situ, are weight-averaged to produce climatological values for each month of the year. An average, monthly varying ice mask is used. A temporal interpolation followed by a spatial interpolation based on classic triangulation of available nearest neighbors is performed to fill up missing information. The resulting climatology is compared with previous climatologies and analyzed for seasonal variability on regional to global scales.

OS42E MC: 132 Thursday 1330h

Pushing the Envelope: A Tribute to the Career and Accomplishments of John M. Edmond III *(joint with H, T, V, GC, PP, HG)*

Presiding: **K L Von Damm,** University of New Hampshire**; P Molnar,** Dept. of Geological Sciences, CIRES, Univ. of Colorado

OS42E-01 1330h

Joining Observations Hitherto Neglected: Mistaken Andean Rising Mountains, Ice On Norway, ENSO Displacement, Mountains, Oxygen-18, NAO Development

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John Edmond stimulated us all to consider unusual points of view, regardless of their validity. In that vein, we suggest that changes in the tropical Pacific triggered global cooling leading to northern hemisphere glaciation. If taken strictly as a thermometer and not dependent on salinity, oxygen isotopes from early Pliocene planktonic foraminifera in the equatorial Pacific (Cannariato and Ravelo, 1997) would put the warm pool in the eastern Pacific, not the west. Geologists throughout the world have argued that their favorite mountain ranges rose rapidly in Plio-Quaternary time, but as John Edmond has said in other contexts, This is nonsense. Climate change provides a simpler explanation for data used to infer recent rises of ranges in the extratropics. Floristic changes have been used to suggest that the (tropical) Colombian Andes also rose at this time, but the change from a warm eastern Pacific to a cold tongue over that region in early to middle Pliocene time should have changed Colombian climate in the direction consistent with misinterpreting it as indicating recent uplift. Present-day teleconnections of El Niño match differences between Pliocene and present-day climates over North America, suggesting that El Niños teleconnections provide a blueprint for Pliocene climate. Accordingly greater export of heat from the tropics, as occurs during El Niiño, maintained a warm Canada in Pliocene time and prevented ice sheets. Others (e.g. Hoerling et al., 2001) have suggested that changes in the tropical Pacific affect the North Atlantic Oscillation (NAO). A strengthened NAO in Pliocene time would maintain a warm Fennoscandia, preventing ice sheets there. In keeping with John Edmonds blunt direct approach, we leave you with a simple thought: To Have Ice Sheets Implies Simply Negating Omnipresent Non-Stop El Niiño, & Starting ENSO.

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The disposition of the PGEs in marine sediments and the K/T boundary

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The marine record of PGEs and 187Os/188Os provides information on different inputs of PGEs into the oceans. Some studies suggest that the PGEs may suffer post-depositional mobility. In some K/T boundary clays, the relative abundances of PGEs differ significantly from chondritic, which is the signature expected from fallout of the meteorite impact (Kyte and others). In addition, elevated Ir is sometimes observed as far as 1 meter from the cm-thick boundary clay containing the meteoritic ejecta (Zhou and Kyte, 1992). We determined PGE abundances of boundary clays at two originally hemipelagic sites (Denmark and Spain, where previous studies showed that the Ir anomaly is confined to within a few cm), and two pelagic Pacific sites (a boundary clay from the N Pacific (DSDP 465A) characterized by a 0.5 m thick Ir anomaly and a transect across the K/T boundary in the S Pacific (DSDP 596) where the Ir anomaly spans 2 m). The Danish, Spanish, and N Pacific sites are characterized by marls and limestones, whereas the S Pacific site is dominated by clays. Samples were spiked with isotopic tracers, mixed with a flux, S and Ni, and equilibrated by fusion. PGEs were extracted from Ni-sulfide and analyzed by ICP-MS. The Spanish and Danish boundary clays have near-chondritic PGE abundance patterns. The two Pacific sites have similar PGE patterns at the peak, but the patterns are not chondritic as found earlier by Evans et al. (1995). The two sites are extremely depleted in Os (Os/Ir = 0.07-0.15) and slightly enriched in Pd and Pt relative to Ir. The S Pacific site shows a 2 m wide, roughly symmetric PGE profile across the K/T boundary, consistent with Ir data of Zhou and Kyte. This cannot be explained by bioturbation, as the mixing effect should decrease exponentially with a lengthscale of 10-20 cm. The log of the Pt, Pd, Ir, and Ru in the upper part of this section are linearly correlated with the square of distance from the peak, and thus reflect diffusive transport. Effective diffusivities determined from the slope of these linear fits, assuming 65 Ma, range from $10^{-12} - 10^{-13}$ cm^2/s ($D_{Ir} = 5 \times 10^{-13}$, $D_{Ru} = 4 \times 10^{-13}$, $D_{Pt} = 1 \times 10^{-12}$, $D_{Pd} = 1 \times 10^{-12}$. These values are much smaller than those of very soluble cations in pore waters, which have Ds of 10^{-6} cm^2/s. Thus, diffusion is not the limiting factor in the mobilization of PGEs, but is itself likely to be limited by chemisorption/reprecipitation. The integrated Os content in the 2 m section is a tenth of that expected from Ir. Either most of the Os was lost from the boundary clay shortly after deposition and deposited elsewhere, or it was redistributed over larger lengthscales than inferred from the Pt, Pd, Ir, and Ru profiles. Distributing the missing Os over 40 m of sediment by diffusion ($D \sim 10^{-9}$) results in Os levels similar to the levels in sediments away from the K/T boundary. If this is the case, the Os in the two Pacific sites must have had a higher D and/or was much more soluble than the other PGEs. Redistribution of K/T Os in the sedimentary column over large lengthscales will complicate the interpretation of the marine Os isotopic record and the relationship of 87Sr/86Sr and 187Os/188Os. There is also a large increase in Pt and Pd in the Pacific sections far from the K/T boundary, requiring input from terrestrial sources without significant addition of Ir or Os. The near-chondritic PGE patterns in the Danish and Spanish sites suggests that under certain unknown conditions, the PGEs are immobile. The PGEs appear to have complex chemistry and transport properties that are not yet understood. Div. Contrib. 8773(1084).

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Lithium isotopes as a probe of weathering processes

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Lithium isotopes have the potential to be effective tracers of weathering processes due to their large relative mass difference and therefore fractionation. In this study an attempt is made to fill a major gap in the knowledge of Li isotope fractionation during continental weathering and of the mechanisms involved. Finally the relationship between the suspended and dissolved material is made on a basin-wide scale. The Orinoco basin provides a clear contrast in reaction-limited and transport-limited weathering regimes that has already been documented by a comprehensive study on its fluvial geochemistry. Conspicuous in our new results is the difference in δ^6Li of the dissolved load between the Andean (-30 to -22 $^o/_{oo}$) and Shield (-22 to -7 $^o/_{oo}$) tributaries, while the δ^6Li of the suspended load is similar between the two. To a first approximation, during superficial weathering in high relief, tectonically active terrains the dissolved load is high in Li and isotopically heavy (more negative δ^6Li), whereas in stable shield regions the concentrations are low and isotopically light in proportion to the increasing degree of weathering.