

# KEOPS

Last update : 2009 oct. 20

From : Tom Trull –Diana Davies

## Trull\_Metadata\_report

### Project title

Characterisation of suspended and sinking particles to quantify carbon, nitrogen, and silicon export from surface waters

### Name, address, phone, fax, e-mail of responsible scientist

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### Overview of the project

The overall goal of this work is to contribute to the KEOPS Project Objective 2.2., to characterize the magnitude and nature of carbon export to the ocean interior in sinking particles, and its influence on global carbon budgets. The approach has several strands:

#### A. Identification of phytoplankton responsible for export

*Method:* Comparison of  $^{13}\text{C}$ -POC compositions of different size fractions (335, 200, 55, 20, 5, 1  $\mu\text{m}$ ) with  $^{13}\text{C}$ -DIC enrichments in surface waters produced by seasonal DIC depletion

*Reference:* Trull and Armand, 2001

#### B. Examination of new versus recycled production

*Method:* Comparison of  $^{15}\text{N}$ - $\text{NO}_3$  and  $^{15}\text{N}$ -PON compositions to distinguish new vs. recycled production, and possible response to Fe - new production is  $^{15}\text{N}$  rich and this enrichment increases with increased iron availability.

*Reference:* Karsh, Trull, Lourey, and Sigman, 2003.

#### C. Optical Characterization of the forms and sizes of sinking particles

*Method:* Deployment of polyacrylamide gels in sediment trap tubes to obtain sinking particles without disturbing their forms, followed by photomicroscopy and image analysis.

*Reference:* Waite and Nodder, 2001

#### D. Calibration of $^{13}\text{C}$ and $^{15}\text{N}$ signatures of biological pump strength

*Method:* Comparison of  $^{15}\text{N}$  N-PON compositions with seasonal nitrate depletion,  $^{13}\text{C}$ -POC compositions with surface  $\text{pCO}_2$  values, and KEOPS results with Fe-poor SAZ results and SOIREE artificial iron fertilization Fe-rich results.

*References:* Lourey, Trull and Sigman, 2003; Lourey, Trull and Tilbrook, 2004.

# KEOPS

Last update : 2009 oct. 20

From : Tom Trull –Diana Davies

## **Title(s) of anticipated publication(s)**

- i) Estimation of export from  $^{234}\text{Th}$  and drifting sediment trap observations during the KEOPS program (N.Savoie, T. Trull, others)
- ii) Optical characterisation of sinking particles using polyacrylamide gels during the KEOPS program (F. Ebersbach, T. Trull)
- iii) Identification of export contributions from phytoplankton functional groups using  $^{13}\text{C}$  and  $^{15}\text{N}$  analyses during the KEOPS program (T. Trull)

## **Data description**

**Suspended and sinking particle collections are described in the file:**

**Trull\_PumpTrapGel\_database.xls**

## **Parameters and methodology**

1.  $^{234}\text{Th}$  - analysis carried out onboard ship in collaboration with Dr. Nicolas Savoie and is described in his report.
2. Particulate Organic Carbon (POC)
3. Particulate Organic Nitrogen (PON)
4. Particulate Biogenic Silica (BSi)
5.  $\delta^{13}\text{C}$  of POC
6.  $\delta^{15}\text{N}$  of PON
7.  $\delta^{29}\text{Si}$  of BSi - this analysis will be carried out in collaboration with Dr. Damien Cardinal (Brussels).

In addition to the particle samples, additional samples for dissolved inorganic carbon isotopic compositions and dissolved nitrate nitrogen isotopic compositions were collected from the CTD-Niskins (sample sites are listed in detail in the CTD database, and focused on high vertical depth resolution casts at sites A3 and C11, accompanied by surface mixed layer samples taken along the transects.

8. ( $\delta^{13}\text{C}$  -DIC)
9. ( $\delta^{15}\text{N}$ -NO<sub>3</sub>)
10. Photomicroscopy of gels

Analytical methods for all parameters are described in Trull and Armand, 2001 and Karsh et al., 2003, except BSi and  $\delta^{29}\text{Si}$  of BSi., which are described in Cardinal et al. 2005, and 10. which is described in Waite and Nodder, 2001.

## **Sampling strategy**

See above

## **Planning for data availability**

As per KEOPS deadlines

## **Data file description (name of parameters, column # of each parameter, ...)**

See data file

## **References**

## KEOPS

Last update : 2009 oct. 20

From : Tom Trull –Diana Davies

Cardinal, D., Alleman, L. Y., Dehairs, F., Savoye, N., Trull, T. W. and André, L. (2005) Dissolved silicate  $\delta^{29}\text{Si}$  variations in the Southern Ocean. *Global Biogeochemical Cycles*, *in press*.

Karsh, K. L., Trull, T. W., Lourey, M. J. and Sigman, D. M. (2003) Relationship of nitrogen isotope fractionation to phytoplankton size and iron availability during the Southern Ocean Iron RElease Experiment (SOIREE). *Limnology and Oceanography* 48, 1058-1068.

Trull, T. W. and Armand, L. (2001) Insights into Southern Ocean carbon export from the  $\delta^{13}\text{C}$  of particles and dissolved inorganic carbon during the SOIREE iron fertilisation experiment. *Deep-Sea Research II* 48, 2655-2680.

Waite, A. and Nodder, S. D. (2001) The effect of *in situ* iron addition on the sinking rates and export flux of Southern Ocean diatoms. *Deep-Sea Research II* 48, 2680-2700.

## KEOPS

Last update : 2009 oct. 20

From : Tom Trull –Diana Davies

### **Trull Cruise Report**

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### **Characterisation of suspended and sinking particles to quantify carbon, nitrogen, and silicon export from surface waters**

#### **Abstract**

Particules a ete collectionnees pour etudier l'exportation de carbone, azote, et silice de la surface vers la mer profond. La recolte a focalise sur deux methodes:

- i) la pompe "HOPU" pour filtrer des centaines de litres a travers des filtres de plusieurs tailles
- ii) la mise a l'eau des pieges sedimentaires derivants.

Les echantillons seraient analyses pour:

1.  $^{234}\text{Th}$  (en collaboration avec Dr. Nicolas Savoye voir son rapport )
2. POC et  $^{13}\text{C}$ -POC, PON et  $^{15}\text{N}$ -PON, BSi et  $^{29}\text{Si}$ -BSi
3. Distributions de taille des particules par photomicroscopie et analyse d'images. D'autre echantillons a ete pris du CTD pour l'analyse de  $^{13}\text{C}$ -DIC and  $^{15}\text{N}$ -NO<sub>3</sub>.

Les echantillons seraient d'abord analyse pour le  $^{234}\text{Th}$ . Les autres analyses commenceraient en septembre, 2005, avec disponibilite de resultats vers le fin de 2005 (POC, PON, BSi) et en mi-2006 ( $^{13}\text{C}$ ,  $^{15}\text{N}$ ,  $^{29}\text{Si}$ ).

#### **Abstract**

Suspended and sinking particles were collected for shipboard and laboratory analyses to characterize particle properties important to the estimation of carbon, nitrogen, and silicon export to the ocean interior in sinking particles.

Sample collection focused on two approaches:

- i) "HOPU" hose pump to filter large volumes of near-surface water for several size fractions of suspended particles
- ii) Sediment traps deployed below the surface mixed layer to obtain sinking particles

Samples will be analysed for:

1.  $^{234}\text{Th}$  (in collaboration with Dr. Nicolas Savoye - see his report)
2. POC and  $^{13}\text{C}$ -POC, PON and  $^{15}\text{N}$ -PON, BSi and  $^{29}\text{Si}$ -BSi
3. Size distributions of the sinking particles via microscopy and image analysis

## KEOPS

Last update : 2009 oct. 20

From : Tom Trull –Diana Davies

Additional samples for  $^{13}\text{C}$ -DIC and  $^{15}\text{N}$ - $\text{NO}_3$  analyses were collected from the CTD - Niskin bottles, as detailed below and in the CTD database. Additional analyses are planned on particle samples collected using the GONI Go-Flo bottles as described in the report by Dr. Andrew Bowie

Because all samples will first be analysed for  $^{234}\text{Th}$  and associated backgrounds, analysis of other parameters will begin in September 2005. Completion of elemental analyses (POC, PON, BSi) is expected in late 2005 and isotopic analyses in mid 2006.

### **Overview of Scientific Objectives**

The overall goal of this work is to contribute to the KEOPS Project Objective 2.2., to characterize the magnitude and nature of carbon export to the ocean interior in sinking particles, and its influence on global carbon budgets. The approach has several strands:

#### **A. Identification of phytoplankton responsible for export**

*Method:* Comparison of  $^{13}\text{C}$ -POC compositions of different size fractions (335, 200, 55, 20, 5, 1  $\mu\text{m}$ ) with  $^{13}\text{C}$ -DIC enrichments in surface waters produced by seasonal DIC depletion

*Reference:* Trull and Armand, 2001

#### **B. Examination of new versus recycled production**

*Method:* Comparison of  $^{15}\text{N}$ - $\text{NO}_3$  and  $^{15}\text{N}$ -PON compositions to distinguish new vs. recycled production, and possible response to Fe - new production is  $^{15}\text{N}$  rich and this enrichment increases with increased iron availability.

*Reference:* Karsh, Trull, Lourey, and Sigman, 2003.

#### **C. Optical Characterization of the forms and sizes of sinking particles**

*Method:* Deployment of polyacrylamide gels in sediment trap tubes to obtain sinking particles without disturbing their forms, followed by photomicroscopy and image analysis.

*Reference:* Waite and Nodder, 2001

#### **D. Calibration of $^{13}\text{C}$ and $^{15}\text{N}$ signatures of biological pump strength**

*Method:* Comparison of  $^{15}\text{N}$  N-PON compositions with seasonal nitrate depletion,  $^{13}\text{C}$ -POC compositions with surface  $\text{pCO}_2$  values, and KEOPS results with Fe-poor SAZ results and SOIREE artificial iron fertilization Fe-rich results.

*References:* Lourey, Trull and Sigman, 2003; Lourey, Trull and Tilbrook, 2004.

### **Details of particle collections and planned analyses**

Particle collection techniques focused on three approaches:

## KEOPS

Last update : 2009 oct. 20

From : Tom Trull –Diana Davies

1. filtration of hundreds of litres of seawater using the "HOPU" hose pump, from near-surface depths (20,60,100, and 130m), to obtain several size fractions (1000-335, 335-210, 210-55, 55-20, 20-5 and 5-1 microns). Deployments were carried out in order at the following sites A11, C11, B11, B5, A3, C5, C1 (20m only because the pump was lost at this site), A3 (20m only using the PUFÉ pump).
2. collection of sinking particles using the INSU PPS3 drifting sediment trap deployed for approximately 24 hours at 200m depth at sites A3 (3/2/05), C5, A3 (12/2/05). Loss of the ACE sediment traps at the first deployment at A3 (18/1/05) prevented the collection of particles from two depths (175 and 325m) as originally planned. At each of these sites, 2 carbon samples were collected (and also two trace-metal samples as described in the report from Dr. Andrew Bowie) and filtered through a 350micron screen to remove zooplankton, and onto a 1micron filter for analyses.
3. deployment of polyacrylamide gels in sediment trap tubes to obtain intact aggregates for microscopic examination. Gels were recovered from the following sites and depths: A3 (3/2/05) at 20m; C5 at 100,200,330,430m; A3 (12/2/05) at 100,200,330,430m. Gel deployment and processing is illustrated below in a series of photographs.

All HOPU and PPS3 particle samples will be analysed for the following parameters:

1.  $^{234}\text{Th}$  - this analysis was carried out onboard ship in collaboration with Dr. Nicolas Savoye and is described in his report.
2. Particulate Organic Carbon (POC)
3. Particulate Organic Nitrogen (PON)
4. Particulate Biogenic Silica (BSi)
5.  $\delta^{13}\text{C}$  of POC
6.  $\delta^{15}\text{N}$  of PON
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In addition to the particle samples, additional samples for dissolved inorganic carbon isotopic compositions and dissolved nitrate nitrogen isotopic compositions were collected from the CTD-Niskins (sample sites are listed in detail in the CTD database, and focused on high vertical depth resolution casts at sites A3 and C11, accompanied by surface mixed layer samples taken along the transects.

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### References

Cardinal, D., Alleman, L. Y., Dehairs, F., Savoye, N., Trull, T. W. and André, L. (2005) Dissolved silicate  $\delta^{29}\text{Si}$  variations in the Southern Ocean. *Global Biogeochemical Cycles*, in press.

## KEOPS

Last update : 2009 oct. 20

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Lourey, M. J., Trull, T. W. and Sigman, D. M. (2003) Sensitivity of the  $\delta^{15}\text{N}$  of surface suspended and deep sinking particulate organic nitrogen to Southern Ocean seasonal nitrate depletion. *Global Biogeochemical Cycles* 17, 1081,doi:10.1029/2002GB001973.

Lourey, M. J., Trull, T. W. and Tilbrook, B. (2004) Sensitivity of  $\delta^{13}\text{C}$  of Southern Ocean suspended and sinking organic matter to temperature, nutrient utilisation and atmospheric  $\text{CO}_2$ . *Deep-Sea Research I* 51, 281-305.

Trull, T. W. and Armand, L. (2001) Insights into Southern Ocean carbon export from the  $\delta^{13}\text{C}$  of particles and dissolved inorganic carbon during the SOIREE iron fertilisation experiment. *Deep-Sea Research II* 48, 2655-2680.

Trull, T. W., Sedwick, P. N., Griffiths, F. B. and Rintoul, S. R. (2001) Introduction to special section: SAZ Project. *Journal of Geophysical Research* 106, 31425 -31430.

Waite, A. and Nodder, S. D. (2001) The effect of *in situ* iron addition on the sinking rates and export flux of Southern Ocean diatoms. *Deep-Sea Research II* 48, 2680-2700.

### **Figures**

Figure 1. INSU PPS3 Sediment trap modified to carry ACE CRC polyacrylamide gels.

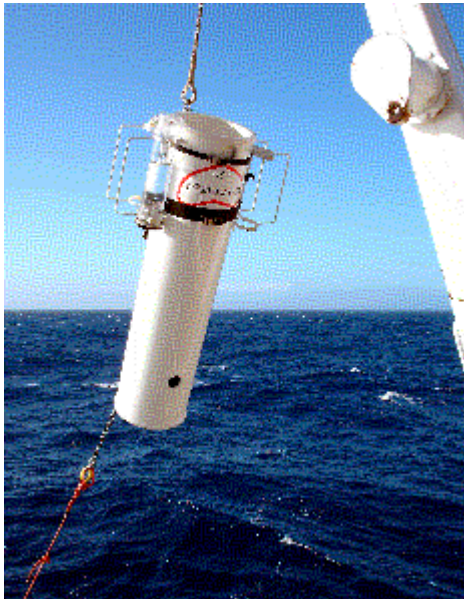


Figure 2. Polyacrylamide gel filled with sinking particles



## KEOPS

Last update : 2009 oct. 20

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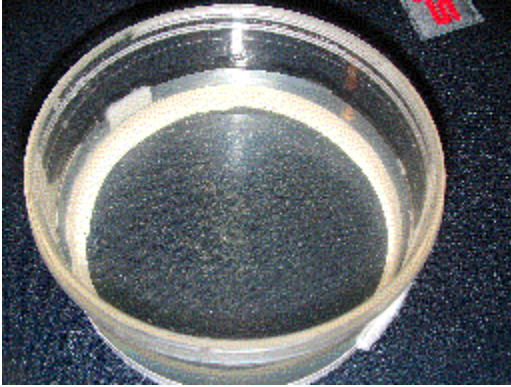


Figure 3. View of gel under microscope and image of faecal pellets in the polyacrylamide gel at 50x magnification, as operated by project scientist Friederike Ebersbach

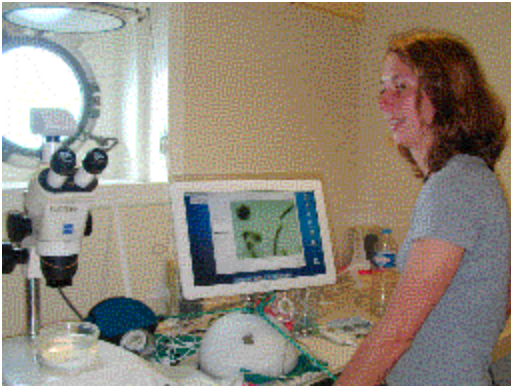


Figure 4. View of image processing - 6.5x magnification greyscale image at right, thresholded binary image at left for semi-automated characterisation of particle size and shape. Grid is 14mm across. Cake provides additional scale and sustenance for project scientist 'Curly' Ebersbach.

