Medical CT-images of contourite cores: An onset to processing and data interpretation

Thomas Vandorpe[1], David Van Rooij[1], Susana Lebreiro[2], Belen Alonso[3], Anxo Mena[4], Veerle Cnudde[1] and Francisco Javier Hernandez-Molina[5]

1 Dpt. Geology & Soil Science, Ghent University, B-9000 Ghent, Belgium. Thomas.Vandorpe@ugent.be; David.VanRooij@ugent.be; Veerle.Cnudde@ugent.be
2 IGME, Madrid, Spain. susana.lebreiro@igme.es
3 Instituto de Ciencas del Mar, CSIC, Barcelona, Spain. belen@icm.csic.es
4 Departamento de Xeociencas, University of Vigo, Vigo, Spain. anxomena@uvigo.es
5 Department of earth sciences, Royal Holloway University of London, London, UK. Javier.Hernandez-Molina@rhul.ac.uk

Abstract: *Although CT scans are being used in scientific research since the late 1970's, they are only recently being used in contourite research. Mostly a vertical slice through or an X-radiograph of the sediment core is shown, not displaying the three-dimensional variations within the sediment core. These can be very important however. This research attempts to discern components within the entire core based on their radio-density values, using the 3D analysis software "Morpho+", developed by the UGCT (Ghent University Centre for X-Ray Tomography). The abundance of each component is displayed throughout the sediment core and will be compared to MSCL, XRF and grainsize data in order to derive what information is held within CT scans. By scanning muddy, silty and sandy contourite cores (both compacted and not), a non-exhaustive reference set of CT scans for contourite cores will be created.*

Key words: *CT scanning, contourites, Gulf of Cádiz, MSCL, XRF.*

INTRODUCTION

X-ray computed tomography (CT) is a non-destructive technique enabling researchers to obtain information of the internal structure of an object (Brabant et al. 2011). CT-images in sediment core sections may display features not visible with the naked eye or on core-pictures, such as distinct layers, bioturbation, cracks, and weathering effects (e.g. Dewanckele et al. 2014) and as such it is a tool which has been used to further improve core interpretations. CT imagery in contourite research is scarce so far. Some authors (e.g. Rebesco et al. 2012 and Voigt et al. 2013) use X-radiographs, which do not take into account the full 3D variations within a core. Lateral variations are of high importance and should be taken into account. This research focusses on several contourite cores from the Alboran Sea and the Gulf of Cádiz containing muddy, silty and sandy intervals in order to assess what extra information can be obtained from CT scans and to generate a preliminary reference set of CT scans against which future cores can be compared.

MATERIAL AND METHODS

Over 5 meters of sediment core GC01 (northern Gulf of Cadíz) were scanned with the SOMATON definition flash scanner of the Ghent University hospital. A 120kV step and rotation time of 1 second were set by which a x and y-resolution of 0.2mm and z-resolution of 0.6mm was obtained. The images were reconstructed using the "J37s medium smooth" algorithm. The analytical software package Morpho+ (Brabant et al., 2011) from the Centre for X-ray Tomography of the Ghent University was used in order to discern different components based on the radio-density values histogram (Fig. 1), a measure for changes in density and average atomic number. These components are isolated and quantified in comparison to the total volume of interest.

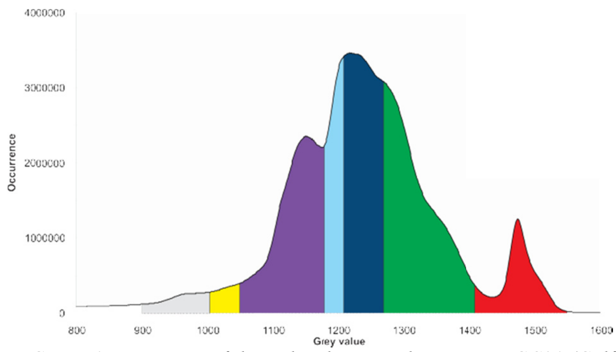

FIGURE 1. Histogram of the radio-density values in core GC01 (Gulf of Cádiz). The colours in this histogram correspond to those in Fig.2.

INITIAL RESULTS

The colours within the vertical section (Fig. 2) generally only show the component which has the highest percentage in that interval. However other components are not fully absent within those zones, e.g. between 2150 and 2550 cm the dominant component is the purple one while the light blue component is not absent (up to 20%). There is as well an important amount of the yellow (up to 7.5%) component present (Fig. 2). Also although never really visible in the core image, the red component is never totally absent and has sometimes percentages up to 5% (e.g. 900m, Fig. 2).

Based on the abundance of the different components, at least 14 units can be distinguished (Fig. 2). These units almost exactly match XRF-defined zones (cfr. Fe/Ca and Si/Al curves in Fig. 2). Zone 2 (green box in Fig. 2) consists mostly of the green component and correlates with Si/Al values. The variation of the other CT-components can however still be used in order to derive intra-zone variations. In this case the red component, indicating very high radio-density values still shows a lot of variation. It has to be noted that XRF measures the chemical composition of the top millimetre of a split core, which may not be the same throughout the entire horizontal slice of the core this measuring point represents. A CT scan measures the radio density of that entire horizontal slice and may as a result potentially reveal more information on the core.

FUTURE RESEARCH

Further comparisons to XRF, MSCL and grain-size data will be carried out to find out what the different components represent and how they can be used to further interpret contourite cores. To achieve this goal, contourite sections from various settings will be scanned in order to compile an initial reference set against which future scans can be compared.

ACKNOWLEDGEMENTS

The authors acknowledge FWO grant "Contourite-3D" for financing this project, and Prof. Dr. E. Achten and Claire Schepens (Radiology unit, UZ Gent).

REFERENCES

Brabant, L., Vlassenbroeck, J., De Witte, Y., Cnudde, V., Boone, M.N., Dewanckele, J., Van Hoorebeke, L., 2011. Three-Dimensional Analysis of High-Resolution X-Ray Computed Tomography with Morpho+. Miscroscopy and Microanalysis 17 (2): 252-263.

Dewanckele, J., De Kock, T., Fronteau, G., Derluyn, H., Vontobel, M., Dierckx, L., Van Hoorebeke, L., Jacobs, P., Cnudde, V., 2014 Neutron radiography and X-ray computed tomography for quantifying weathering and water uptake processes inside porous limestone used as building material. Materials characterization 88: 86-99.

Rebesco, M., Wåhlin, A., Laberg, J.S., Schauer, U., Beszczynska-Möller, A., Lucchi, R.G.., Noormets, R., Accettella, D., Zarayskaya, Y., Diviacco, P., in press Quaternary contourite drifts of the Western Spitsbergen margin. Deep Sea Research Part I: Oceanographic Research Papers, 79: 156-168.

Voigt, I., Henrich, R., Preu, B.M., Piola, A.R., Hanebuth, T.J.J., Schwenk, T., Chiessi, C.M., 2013. A submarine canyon as a climate archive — Interaction of the Antarctic Intermediate Water with the Mar del Plata Canyon (Southwest Atlantic). Marine Geology 341: 46-57.

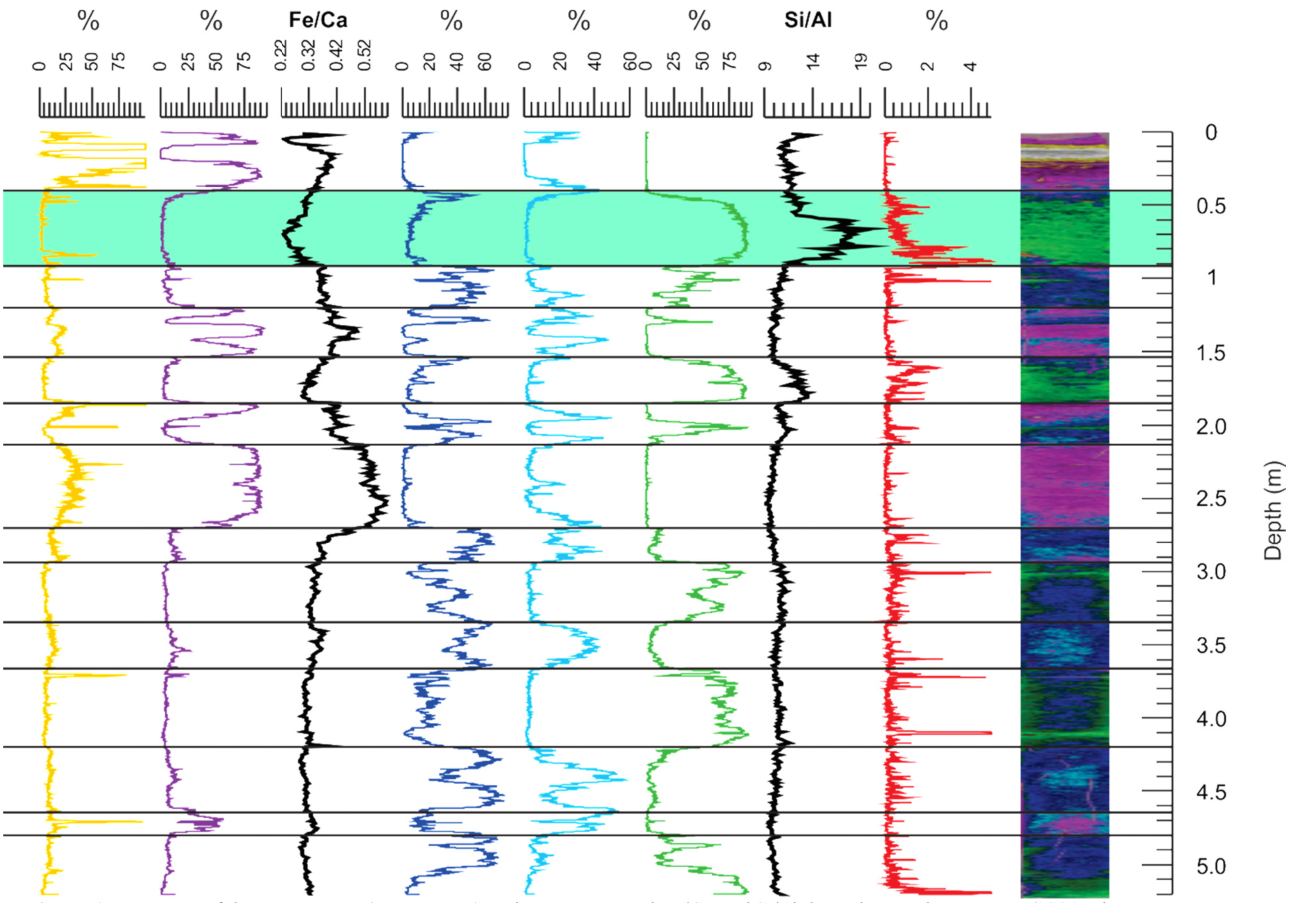

FIGURE 2. Variation of the components (percentages) and XRF-measured Fe/Ca and Si/Al throughout sediment core GC01. The grey component is not displayed in the graphs. A vertical section through the core is given on the right. The black horizontal lines delineate 14 zones based on the CT data. Zone 2 is indicated in green because it shows a good correlation between the green component and the Si/Al data. Also the purple component and the Fe/Ca data display the same trends.