Experimental report

25/02/2016

Proposal: 8-04-720 **Council:** 4/2014

Title: Molecular adaptation of deep sea organisms to high pressure environments

Research area: Biology

This proposal is a continuation of 8-04-665

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Samples: T kodakarensis cells
T barophilus cells
E. coli cells
T. kodakarensis lysed cells

Instrument	Requested days	Allocated days	From	To
IN16B	4	4	11/09/2014	15/09/2014

Abstract:

88% of the oceans volume is considered as a high hydrostatic pressure environment. This environment is known to harbor a variety of prokaryotes which according to certain studies represent up to 70% of the earth's biomass. Many of these organisms are living near to hot vents, at high temperature (around 85°C) and in anaerobic environments, experiencing conditions that are very different from what we can find on the surface of earth. Despite some efforts, the molecular mechanisms underlying their adaptation to extreme conditions are poorly understood. Our goal is to study the cellular water and macromolecular dynamics of these organisms in order to understand how these organisms cope with hostile environments.

Report on IN16B experiment 8-04-720

Molecular adaptation of deep sea organisms to high pressure environments

N. Martinez, P. Oger, B. Franzetti, M. Jebbar, G. Michaud, J. Peters

The goal of this experiment was to complete a study exploring the dynamical features of deep sea living organisms. We started first by measuring data on time of flight spectrometers (IN5 and IN6) at instrumental resolution of 10 and 80 μeV, respectively. When we analyzed the data using a comprehensive model [1] accounting for different parts of the system under study (bulk water, hydration water and biomolecules) there were striking differences in the behavior of fast motions corresponding to rotational motions in biomolecules, but there was also a slow component near the elastic peak describing hydration water motions that was showing great differences. This was only seen on IN5 at 10 μeV resolution, as the quasi-elastic broadening was around 2-3 μeV. Although this data was very valuable, the technical limitations of time of flight instruments (reduced Q-range with increasing resolution) led us to apply for beam time on IN16B, which has a broad Q-range and high energy resolution.

We thus recorded elastic and quasi-elastic data on the same samples (*T. kodakarensis*, a surface organism living at ambient pressure, and *T. barophilus*, a deep sea organism living at high pressure) at room temperature and ambient pressure and 40MPa in order to confirm and complete the features that we observed on TOF instruments.

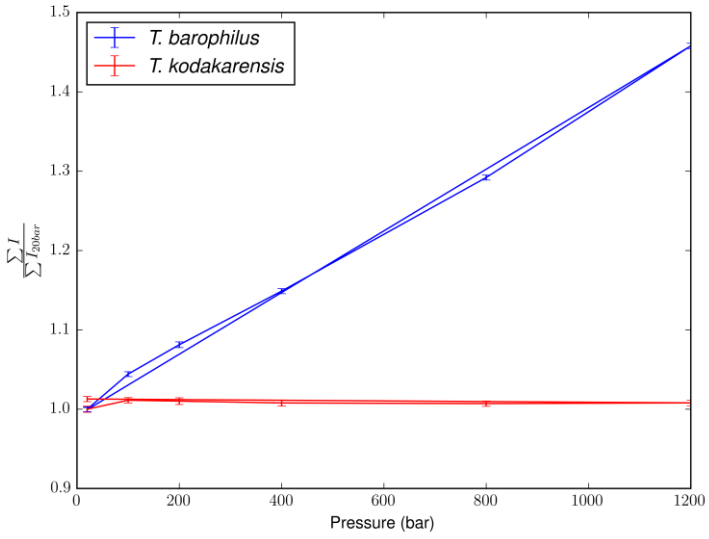

Figure 1: *Elastic intensities summed over all scattering angles as function of pressure for T. barophilus and T. kodakarensis.*

Fig. 1 represents the elastic intensities summed over all scattering angles and normalized to ambient pressure for both samples as function of pressure. We see a significant difference of up

to 40 % between the pressure adapted organism *T. barophilus* and the piezosensitive *T. kodakarensis*, which is much more stable against pressure application.

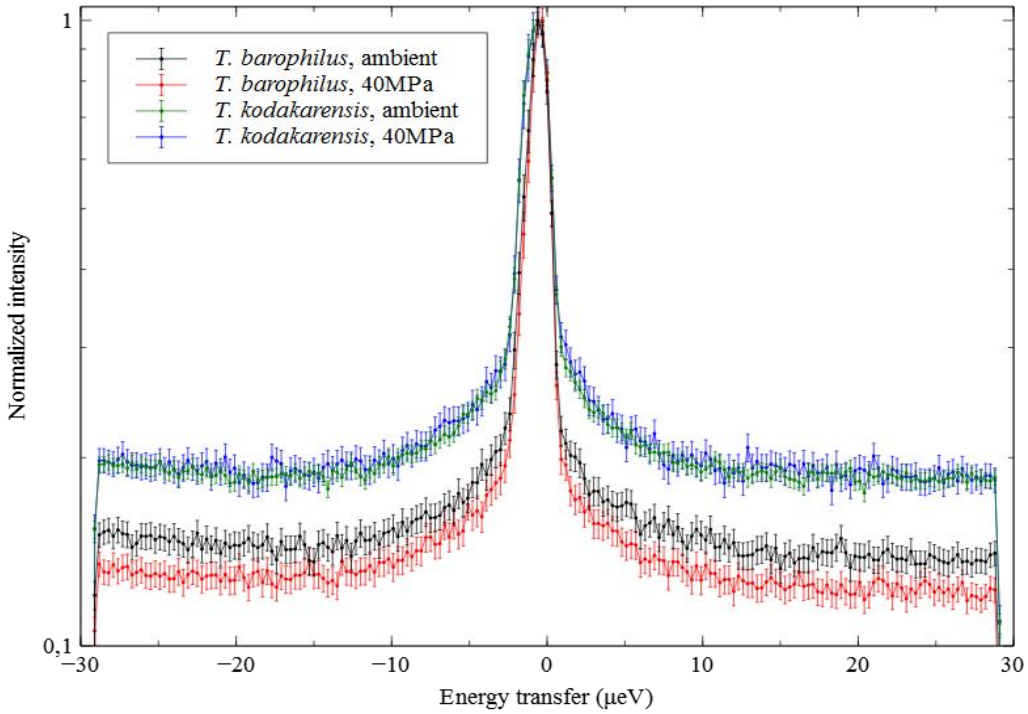

Figure 2: *Q averaged intensity as a function of energy transfer for T. barophilus and T. kodakarensis at different pressure conditions.*

The Q averaged quasi-elastic spectra are shown in fig.2, where we clearly see a difference between the two samples. While there is no response to pressure for *T. kodakarensis*, the *T. barophilus* sees its quasi-elastic line shape change. This comforts the analysis of the IN5 data. For we fitted now the data taken at different energy resolutions with the same comprehensive model, with a program that we have developed [2] and are preparing a publication on this study.

[1] Natali F, Gerelli Y, Stelletta C, and Peters J, 'Anomalous proton dynamics of water molecules in neural tissue as seen by quasi-elastic neutron scattering. Impact on medical imaging techniques', AIP Conference Proceedings 1518: 551-557 (2013)

[2] Martinez N, Natali F and Peters J, 'mQfit, a new program for analyzing quasi-elastic neutron scattering data', EPJ Web of Conferences 83: 03010 (2015)