Twilight zone particulate Ba in the North Pacific:

• What does it tell about organic carbon mineralization in at ALOHA and K2?

• How well does it compare with other carbon flux measurements, especially BCD and NBST $\Delta$POC flux?

• Have we come closer toward a ‘generic’ proxy for twilight zone organic carbon mineralization?
State of the art:

The non-lithogenic fraction of Ba in suspended matter is present mainly as micro-crystalline barite. This barite appears to be formed in degrading biogenic material (aggregates, fecal pellets) settling through the water column. Profiles of suspended Ba usually show increased concentrations at mesopelagic depths, which are related to export and mineralization of organic matter.
Probable scenario for barite formation:

1/ Barite (BaSO₄) formation inside µ-environments
2/ Release of µ-crystals during aggregate break-down and OM mineralization

Mixed layer

Mesopelagic zone
100-1000m

Ba, Sr, Ca, Si → biota

Aggregate formation & export

diss. Ba
Mesopelagic Ba and POC mineralization:

Earlier Southern Ocean results revealed the following empirical relationship:

$$ JO_2 = \frac{[\text{Ba}_{\text{xs}}]_{\text{meso}} - [\text{Ba}_{\text{residual}}]}{17200} $$

*a given respiration rate yields a specific mesopelagic Ba_{xs} conc.*

In terms of POC mineralized and integrated between 150 and 500m (depth range of the sediment traps):

$$ JPOC = JO_2 \times (0.71) \times 350 $$
ALOHA: 7 casts (CTD & MULVFS)
K2 J.D. 209-215: 5 casts (CTD & MULVFS)
K2 J.D. 219-228: 5 casts (CTD & MULVFS)
Clearly more $\text{Ba}_{xs}$ at K2 than at ALOHA

At K2 Ba tends to increase over the study period, generally contrasting with other observations.
At K2 Ca decreases over time..as does PP, NBST fluxes
Ben’s bacterial production data:

Integrated BP

500m/150m int. BP
Twilight zone (150-500m): integrated BP and depth weighted av. $B_{xs}$
Twilight zone carbon utilization:

<table>
<thead>
<tr>
<th></th>
<th>Bacterial C demand$^1$ (150-500m) mgC/m²/d</th>
<th>C demand based on Ba$^ys$ (150-500m) mgC/m²/d</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALOHA</td>
<td>19 – 56</td>
<td>22 – 31 *</td>
</tr>
<tr>
<td>J.D. 177</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALOHA</td>
<td>20 – 61</td>
<td>19 – 28 *</td>
</tr>
<tr>
<td>J.D. 187</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K2</td>
<td>50 – 151</td>
<td>58 – 67 **</td>
</tr>
<tr>
<td>J.D. 223</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K2</td>
<td>58 – 175</td>
<td>81 – 89 **</td>
</tr>
<tr>
<td>J.D. 226</td>
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</tr>
</tbody>
</table>

$^1$ min. : cells/mole TdR = 1*10$^{18}$ and BP/0.15; max. : cells/mole TdR = 2*10$^{18}$ and BP/0.10

* residual Ba$^ys$ taken as 50 and 0 pM, resp.

** residual Ba$^ys$ taken as 150 and 100 pM, resp.
<table>
<thead>
<tr>
<th></th>
<th>NBST ΔPOC flux (150-500m) mgC/m²/d</th>
<th>C demand based on Ba_{xs} (150-500m) mgC/m²/d</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ALOHA #1</strong></td>
<td>14.4</td>
<td>20 – 29 ± 4* (3)</td>
</tr>
<tr>
<td>J.D. 178 - 182</td>
<td></td>
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<tr>
<td><strong>ALOHA #2</strong></td>
<td>14.4</td>
<td>19 – 28 ± 1* (4)</td>
</tr>
<tr>
<td>J.D. 186 - 191</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>K2 # 1</strong></td>
<td>33</td>
<td>27 – 36 ± 22** (5)</td>
</tr>
<tr>
<td>J.D. 209 - 215</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>K2 # 2</strong></td>
<td>10</td>
<td>64 – 73 ± 18** (5)</td>
</tr>
<tr>
<td>J.D. 219 - 225</td>
<td></td>
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</tr>
</tbody>
</table>

* residual Ba_{xs} taken as 50 and 0 pM, resp.
** residual Ba_{xs} taken as 150 and 100 pM, resp.

(n) = number of casts
Twilight zone 150-500m

Meso Ba vs NBST POC flux ratio

BP ratio vs NBST POC flux ratio

lesser attenuation goes with BP extending deeper ...

Excess particulate Ba, pmol/l

Ratio of 500m/150m NBST POC fluxes

500m /150m int. BP

500m/150m NBST POC fluxes

500m/150m int. BP