The supply of iron (Fe) from shelf sediments to the ocean

How far have we advanced our knowledge and what future challenges remain?

Work package 3 of the Shelf Sea Biogeochemistry Programme

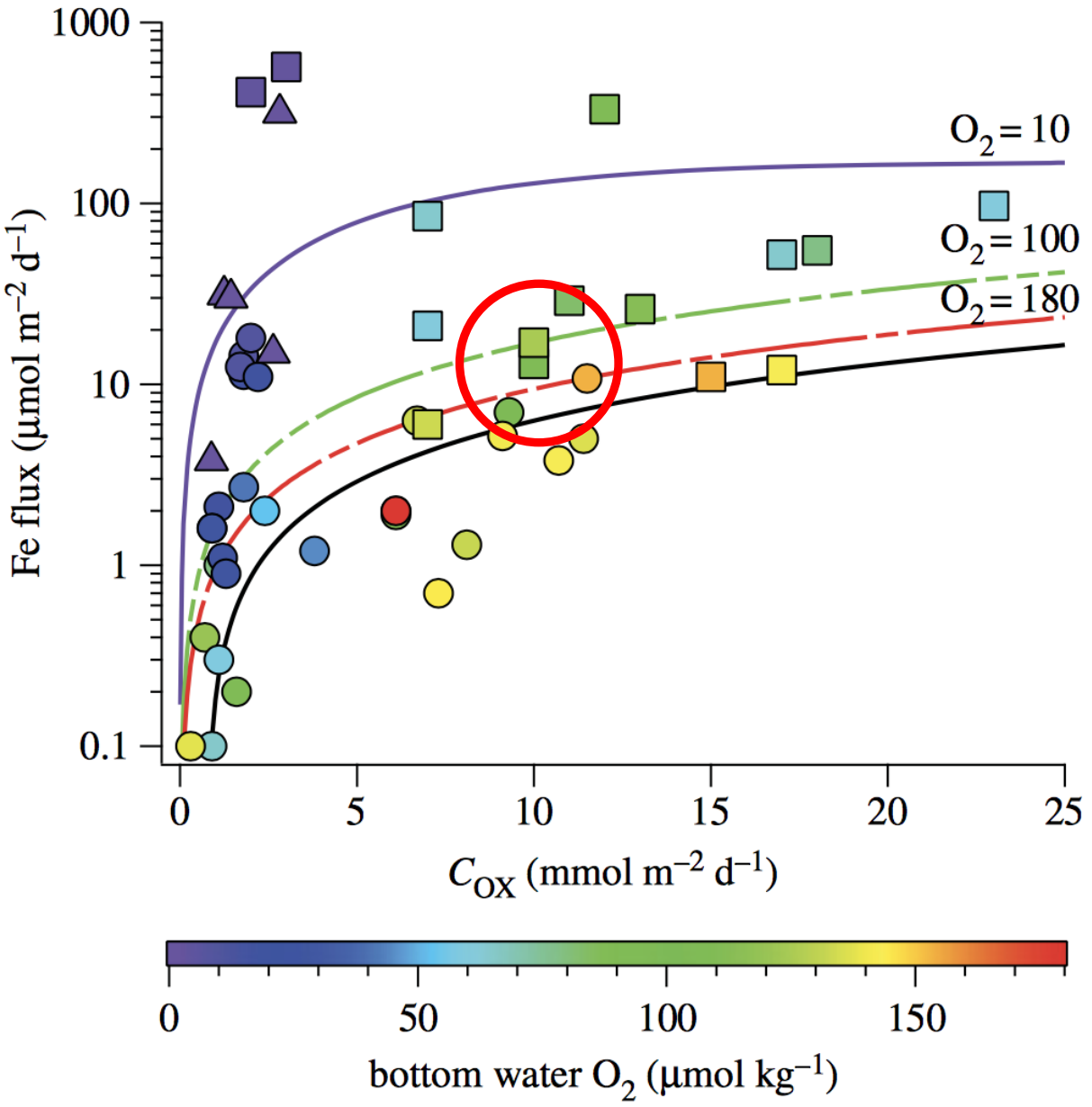
SHELF SEA BIOGEOCHEMISTRY

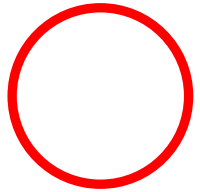
NERC SCIENCE OF THE ENVIRONMENT

Department for Environment Food & Rural Affairs

GEOTRACES

- Intention here is to put WP3 work done in the context of our current understanding and to indicate future challenges
- Clear that shelves can be source of Fe to the ocean (Elrod et al., and Dale et al. for a summary).
- However, focus generally on low oxygen systems. Are more oxic systems, such as Celtic Sea, important and what mechanisms lead to Fe release? What is the fate of any released iron and can it escape to the open ocean?



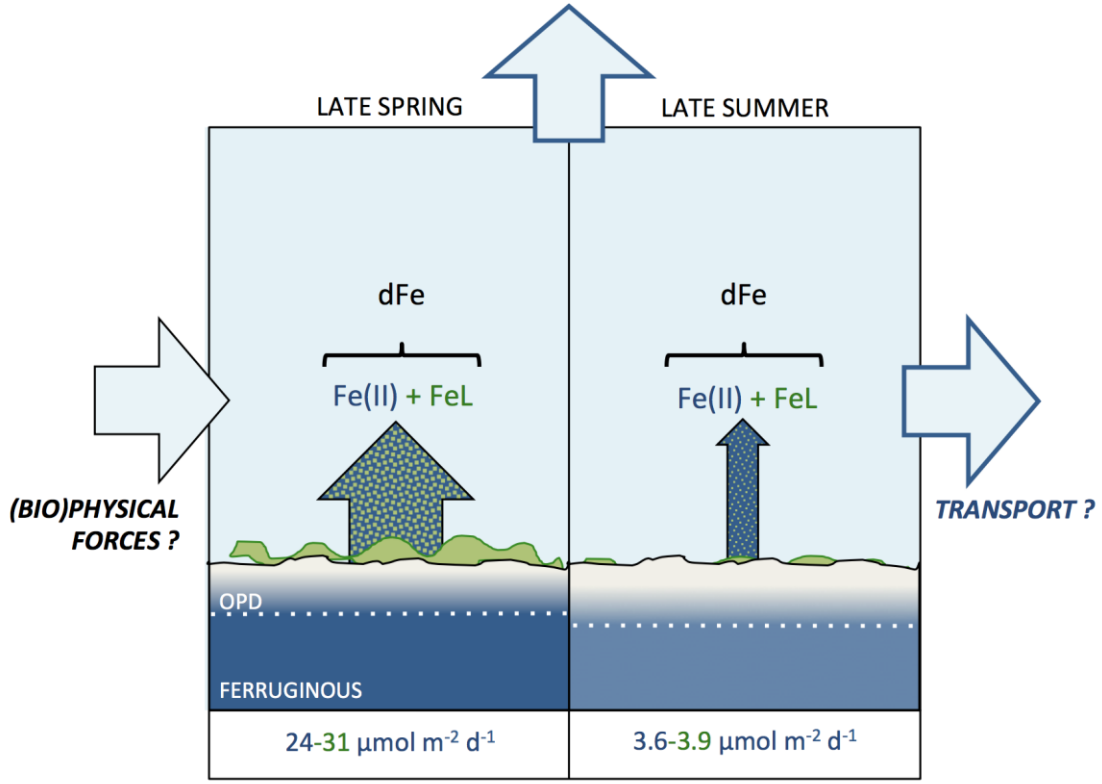


SSB zone

Figure from Homoky et al.
Phil Trans Royal Soc 2016

Sources of Fe from sediments to the water column

- Demonstrated that oxic shelves with cohesive sediments can release dissolved Fe – implications for stabilisation of FeII potentially involving organic ligands
- Episodic releases are linked to carbon inputs. Seasonal story not shown before or taken into account in current estimates of Fe release.

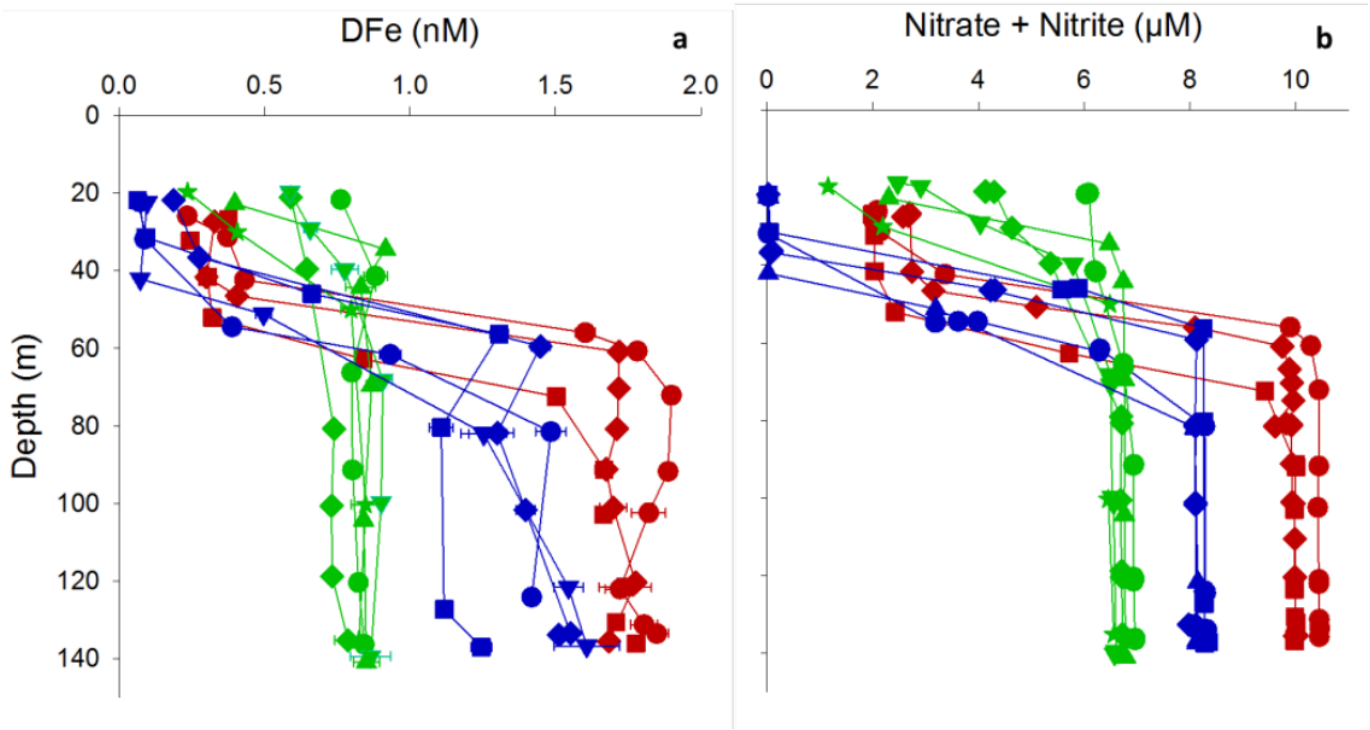


Sources of Fe from sediments to the water column

Also clear that coarse grained sediments can release Fe on a seasonal basis (Sarah Reynolds et al.). Potential to combine both sediment types and temporal and spatial variability in estimating supply of Fe from shelves.

Water column processes

- New detailed seasonal cycle of dissolved Fe shows that v. low concentrations can occur, with issue of potential limitation or co limitation on shelf. Not demonstrated previously. Fe fixed in surface by autotrophs appears to be recycled in deeper waters.

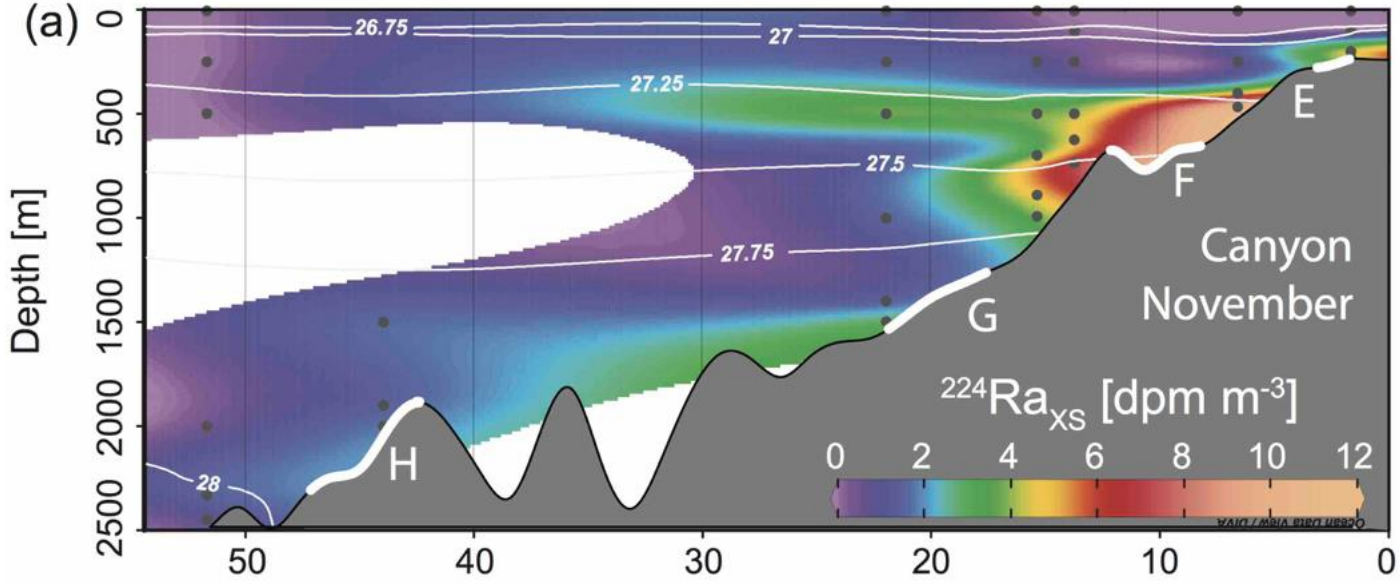


Water column processes

- There is new data on the size spectrum of dissolved Fe showing the colloidal size range (0.02-0.2 µm) is very important on shelf, particularly close to sea floor.
- Also excellent complementary data from Dagmara on set of trace metals with range of biogeochemical characteristics to compare with Fe data.

Transfer of iron to the ocean

- A clear new message is the importance of particulate and colloidal species in transfer of Fe
- Particularly important for nepheloid (high particle) layers on slope as well as shelf.
- Able to combine Fe data with Radium time scales to come up with independent off shelf fluxes of Fe. Powerful tool to be applied elsewhere.



What are the new challenges?

- Whilst we can see high Fe layers in shelf and slope water column, will this Fe be exported into the open ocean?? Partly a question of the physics but also how rapidly is the colloidal and particulate Fe lost from the water column, and to what extent is it retained?
- Is the colloidal Fe in the deep ocean (typically about 40-50% of dissolved Fe) of shelf origin or other sources?
- What is the nature of this colloidal material (sulfides??) and what are the role(s) of associated ligands? How important are ligands to release from sediments and what impact does biological activity have
- How can we effectively model this new information from SSB. Start made with WP4 and now have an excellent data set to test and calibrate models
- In summary SSB has made significant advances in the Fe shelf supply story as reflected in ongoing publications. Also some samples still undergoing analysis and future findings to come.

A final word.....

We acknowledge the scientists in various work packages who have supported WP3 in many ways including during cruises, and with access to data and samples. We have also appreciated NERC support on ships and at Swindon and in particular Tim J. for championing the programme early on and his subsequent oversight, and Phil W. for shepherding our efforts to a successful conclusion .