Suspended sediment composition of the Irrawaddy and Salween Rivers: grain-size dependence and spatiotemporal variations

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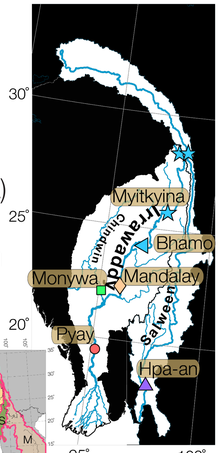
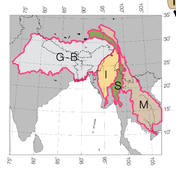
Introduction

Motivation: global landscape and climate dynamics are coupled to weathering. Sediment composition allows quantification and mechanistic understanding of these links.

Modern riverine sediment composition is crucial to interpretation of riverine deposit paleorecords.

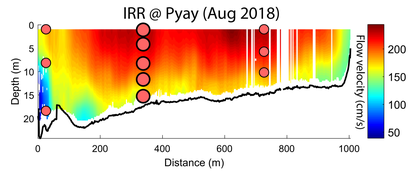
Study site: Irrawaddy (IRR) and Salween (SAL) rivers are a potentially a major source of sediments and carbon to the ocean but data on their chemical and isotopic composition are sparse.

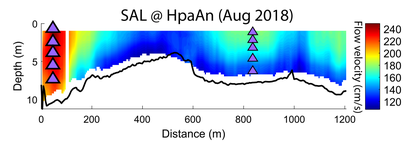


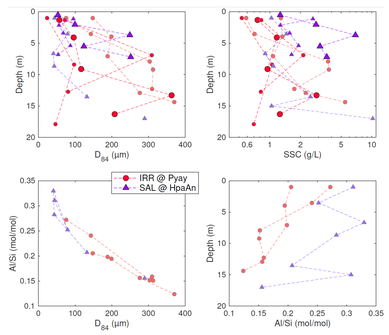


We sampled river sediments at various depths, across the IRR and SAL basins, in monsoon and dry seasons.

Results: discharge, grainsize, sorting





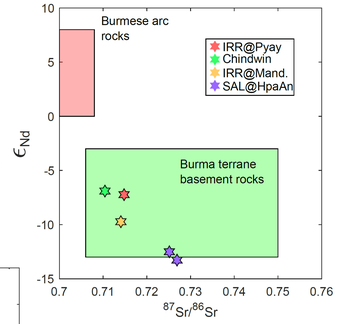


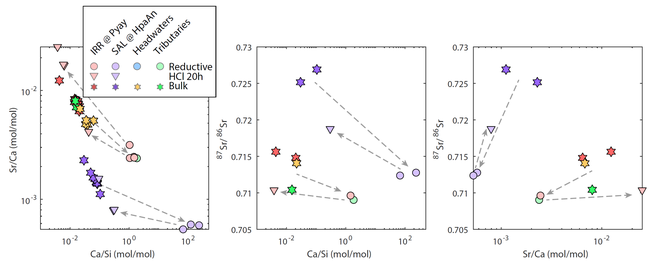
Seasonally discharge varies by 6-10x (SAL: 1600-11000 m^3/s; IRR: 3000-30000 m^3/s) and surface SSC by x10-20 (50-1000 mg/L).

River sediment concentration and composition depends on flow dynamics. We collected ADCP data while sampling sediments vertically and laterally to constrain this variability. **Sediment grainsize and concentration varies strongly with depth.** Al/Si ratio is strongly correlated with grainsize and can be used to normalize for sediment sorting effects.

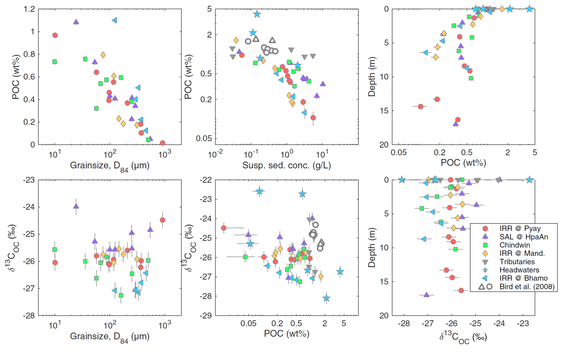
Results: Sr, Nd isotopes

Bulk sediments of IRR vs SAL exhibit distinct Sr and Nd isotope signatures (good agreement w/ prev. published values of Damodararao et al., 2016)**.** There are also significant variations among Irrawaddy tributaries. They can be used to constrain sediment sourcing from the different rock types (Licht et al., 2016)





We carried out multi-step leaching to determine the signature and contribution of various phases (silicate, carbonate, oxide, exchangable)**. Silicates and carbonates have distinct $^{87/86}Sr$ signatures. IRR vs SAL silicates are distinct too.**



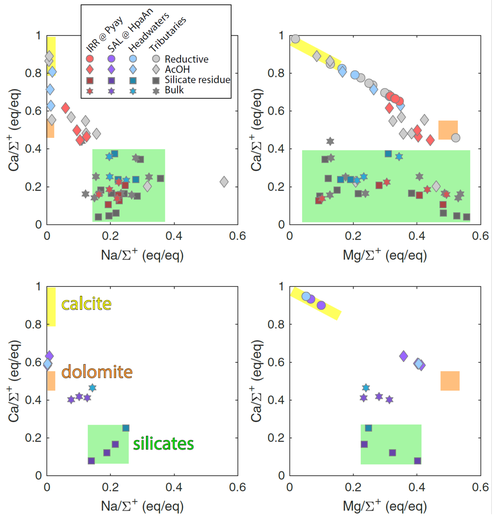
Results: POC, $\delta^{13}C_{OC}$

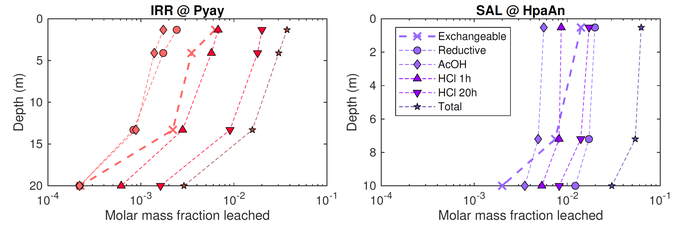
Organic carbon (POC) concentration varies strongly with depth. **IRR vs SAL $\delta^{13}C_{OC}$ signatures are different by ~1‰.** They are variable but not correlated to depth or grainsize suggesting limited petrogenic contribution.

Properly accounting for POC depth sorting will reduce the previously estimated IRR+SAL POC flux (Bird et al., 2008) by about 50%.

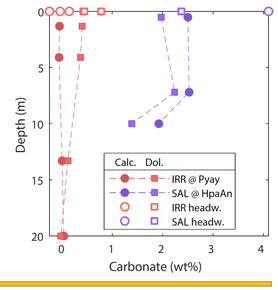
Results: leaching, carbonate vs. silicate fractions

Major element ratios can be used to constrain the silicate, calcite, and dolomite content of sediments.





Phase contribution (i.e. leachable fractions) varies with grainsize (and depth): bottom sediments are more silicate-rich. **At the outlet, IRR sediments contain ~0%, SAL ~5% carbonate.**



Methods

ADCP: RDI Teledyne Rio Grande 1200 kHz
Samples: 9L custom Van Dorn sampler, filtered 0.2μm, freeze-dried
Leaching: 0.4g in 1M NH_4Cl (exchangeable) > 5mM HH (reductive) > 1M AcOH > 1M HCl (1 h) > 1M HCl (20h)
Fusions: 0.1g bulk or silicate residue fused with $LiBO_X$ flux, dissolved in HNO_3
Major elements: Agilent 5100 ICP-OES
$^{87/86}Sr$, εNd: Sr-spec/ L-spec, Thermo Neptune MC-ICP-MS
Major elements: Agilent 5100 ICP-OES
POC, $\delta^{13}C_{OC}$: 10-20mg, liquid 1M HCl decarb,. EA-IRMS

Conclusions

- Depth sampling is necessary to obtain accurate estimates of sediment flux and composition in the Irrawaddy and Salween.
- POC concentration and flux is lower than previously estimated.
- Salween sediments contain significant calcite and dolomite, Irrawaddy sediments are almost exclusively silicate.
- Major element, $^{87/86}Sr$, and εNd composition can be used to distinguish Irrawaddy and Salween sediments and their components (silicate vs. carbonate).

References

Licht et al., 2016, Basin Research
Damodararao et al., 2016, Front. Mar. Sci