Can stratigraphic sequences at all scales be explained by autogenic processes? Applying theory to a real world deltaic succession from the Pyrenean Foreland, Spain

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Introduction:

In sequence stratigraphy, the interpretation of organisation or patterns in stratigraphic successions relies heavily on the assumption that allogenic mechanisms (e.g. eustatic sea level, basin subsidence and sediment supply) are the overriding control on the development of this orgainsation (e.g. Posamentier and Vail, 1988; Neal and Abreu, 2009; amongst many others). Recent theoretical considerations and laboratory flume tank experiments have demonstrated that autogenic mechanisms (e.g. avulsion, autoretreat), in the absence of, or independent allogenic forcing, also exert a major control on the development or organisation in stratigraphic packages (Muto and Steel, 1997; Kim and Paola, 2007; Hajek et al., 2010). Autogenic processes take place over timescales that are commensurate to the scale of the depositional feature under consideration (Hajek and Straub, 2017). Given that this scale-dependant autogenic time can theoretically overlap with allogenic timescales, any interpretation of stratigraphic organisation from 2-dimensional data that necessarily invokes allogenic forcing as the main driver must be questioned. The broad aim of the research project is to (1) bridge the gap between experiments and stratigraphy to further validate the theoretical framework, and (2) to build on this and generate a suite of physical and statistical measures that can independently discriminate between allogenic and autogenic signals, and therefore accurately invert the stratigraphic record.

Project summary:

The student will apply key theoretical relationships to an outcrop example to test the hypothesis that successions interpreted as stratigraphic sequences (*sensu stricto*), and their organisation, can be generated by autogenic mechanisms at a variety of scales. The outcrop example will be the superbly exposed and well-dated Roda Formation (Eocene, Southern Pyrenean Foreland, Spain), which represents a delta complex containing measurable stratigraphic units at all scales from the bed to the whole delta. **Years 1 and 2** will focus of data collection *via* field geological mapping and collection of conventional sedimentary logs, augmented with UAV-derived photogrammetry and structure-from-motion. The student will collect a database of aerial geometries and volumes of stratigraphic elements at all scales, and will analyse their stacking patterns using statistical methods (e.g. Burgess, 2016). **In year 3** the student will also have the opportunity to undertake numerical simulations and analyze data from laboratory deltas to validate theory and field observations. Given the known temporal range of allogenic mechanisms in the studied system, it will be possible to isolate the stratigraphic scale and stratigraphic style that is best explained by either allogenic or autogenic mechansims. It is anticipated that this study will place confidence bounds on whether or not a particular scale of stratigraphic organisation is allogenic in origin or is an artefact of autogenic system behaviour.

The student will receive extensive training in field sedimentology and quantitative analysis of stratigraphy that will equip them for a career in sedimentary geology, and in the analysis of hydrocarbon reservoir geometry and heterogeneity.

Image 1

Image 1 Caption – An example of order in the Eocene Roda Formation in the Oyrenean Foreland, Norther Spain: Beds successively coarsen and steepen upward in this single mouth bar succession.

References

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