# Abstract

## Latitudinal Controls on Submarine Channels: Processes and Deposits

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Submarine fans, the world's largest sedimentary accumulations, were classified for two decades into two end members: high-sinuosity, low-gradient, fine-grained fans, and low-sinuosity, high-gradient, coarse-grained systems. However, the most sinuous modern submarine channels such as the Amazon, Bengal, Indus, and Zaire, along with ancient sinuous submarine channels, such as offshore West Africa and the Gulf of Mexico, are all located in equatorial regions. In contrast, modern submarine channels in higher latitudes approach straight. Quantitative comparison of submarine channel peak sinuosity with latitude reinforces these observations and suggests that there is a very strong latitudinal control on submarine channel sinuosity, with the spectacular high sinuosity channels around the equator, and channels north and south of ~50-60° tending towards straight (Fig. 1). This relationship between peak channel sinuosity and latitude is much stronger than that with slope, demonstrating that the classical fan model fails on a global basis. Such, variation in sinuosity with latitude is unique to submarine channels, with no comparable relationship for terrestrial river channels.

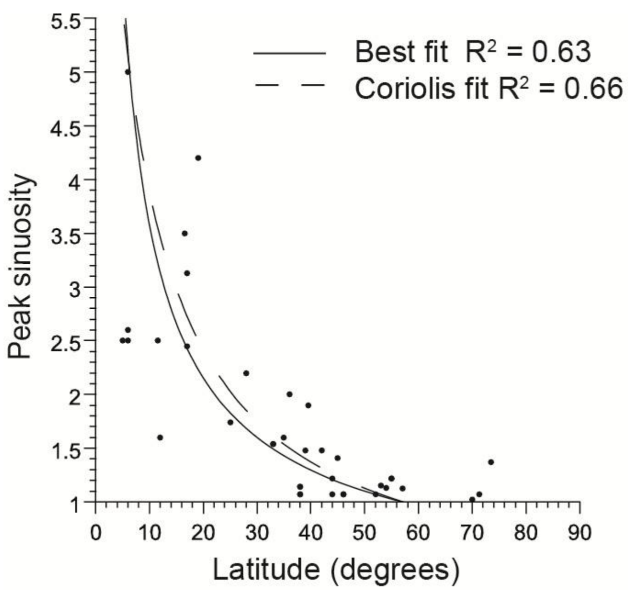


Figure 1. Peak sinuosity versus latitude for submarine channels. Best-fit curve is shown along with fit to inverse Coriolis function. From Peakall *et al*. (2012).

There are a range of possible causal mechanisms for this latitudinal variation, including the Coriolis force, flow type and sediment type. Climatic drivers will be important in shaping submarine channel flow regime, sediment type and potentially sediment concentration, however climate does not vary straightforwardly with latitude, suggesting a relatively weak linkage. Coriolis force, however, varies with latitude alone and produces an excellent fit to the observed sinuosity-latitude distribution (Fig. 1). Interestingly, irrespective of which control predominates, latitudinal global variation in channel sinuosity should also have changed over geologic time. Since sedimentation patterns are linked directly with sinuosity, submarine channel deposits should also vary systematically in space and time.

Here we directly assess the role of the Coriolis force on submarine channels through a set of novel mobile-bed channelized gravity current experiments, where the magnitude of Coriolis forces is changed in order to reproduce conditions at low and high latitudes. We find that deposition and erosion patterns change systematically as Coriolis forces become dominant at high latitudes, leading to the striking result that erosion and deposition only occur on opposite sides of channels. In marked contrast, at low latitudes inner-bank intra-channel bars (point-bars) form on alternate sides of sinuous channels; such deposition will lead to bend growth and sinuosity increase as occurs classically in meandering rivers. Our observations show very good agreement to sedimentation patterns in Coriolis-dominated contourite drift systems and also good agreement with modern and ancient submarine channel deposits. In particular, the results of these experiments are compared to the spectacular ancient submarine channels in the Magallanes Basin in Chile and show that consideration of Coriolis forces can provide a coherent model for the observed migration directions of both small (independent of Coriolis forces) and large channels (dependent on Coriolis forces) in this system, and the associated sedimentation patterns.

In summary, we present evidence that suggests that Coriolis forces are important for channel evolution and sedimentary architecture in some large high-latitude submarine channels, and that such forces are a key driver for the observed latitudinal variation in submarine channel sinuosity. The proposed model suggests that a first order global estimate, based on latitude or palaeolatitude and channel size, can be used to predict over-arching sedimentation processes in modern and ancient channel systems.

**Reference:**

Peakall, J., Kane, I.A., Masson, D.G., Keevil, G., McCaffrey, W. and Corney, R. 2012. Global (latitudinal) variation in submarine channel sinuosity. *Geology*, 40, 11-14.