Geomorphological analysis of different growth stages of a deeply buried submarine fan, Santos Basin, Brazil

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INTRODUCTION

Submarine fans are important depositional systems deposits in the deep-water environment. Modern submarine fans like the Amazon Fan, Indus Fan and Mississippi Fan exhibit vast potential for sediment accumulation, with volumes of hundred thousands (10^5) of km^3 (Walker, 1992). Moreover, this depositional system is relevant for petroleum reservoirs in different basin settings (Weimer and Link, 1991; Pettingill and Weimer, 2002).

Seismic Geomorphology has shown to be a powerful tool to assess deep-water systems, allowing to characterize the geometry and composition of depositional elements and to reconstruct erosion, transport and deposition. However, this approach has been applied mainly to describe a relatively short period of the depositional time, preventing the interpretation of long-term changes in geomorphology and the resulting depositional architecture of individual systems.

Here we present an analysis of the geomorphological evolution of a deeply buried submarine fan in the Upper Cretaceous of northern Santos Basin, SE Brazil (Fig 1).

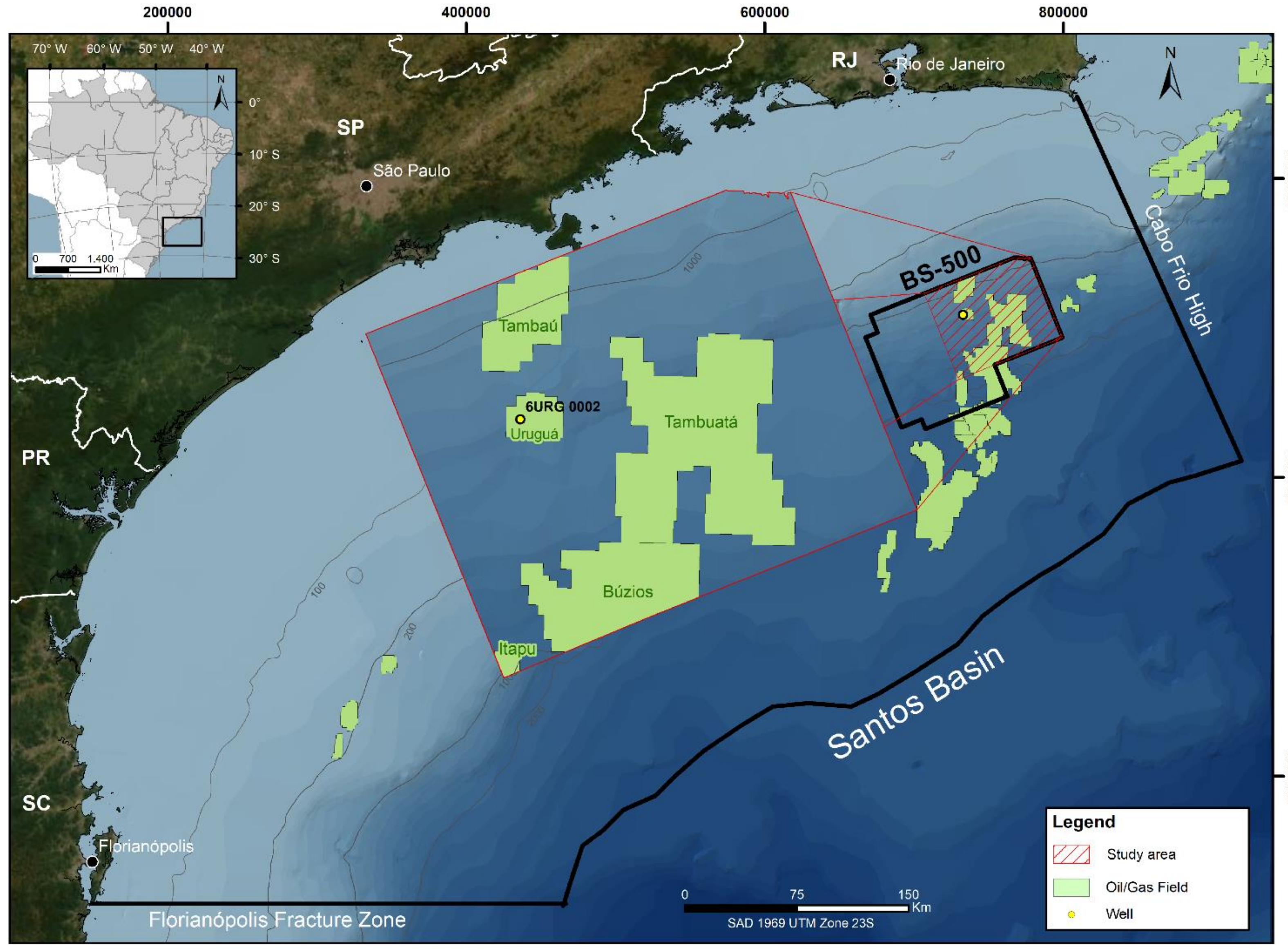

Figure 1: Map of the study area on Santos Basin. The study area is a part of the 3D seismic survey BS-500.

The submarine fan is buried at 3100 m below the seafloor, it has an area of ~700 km^2 and 250 m of maximum thickness. It developed on top of The Maricá Slump, a Maastrichtian mass transport deposit (MTD) derived from instability of sediment accumulated at the shelf edge (Cartlotto and Rodrigues, 2010). At the time of the submarine fan deposition, Santos Basin recorded the maximum dislocation of the coastline toward the basin during the Cretaceous (Moreira et al., 2007).

METHODS

We used a 3D seismic survey (BS-500) – a post-stack migrated seismic with 2 ms sample interval – to map the submarine fan. The well 6URG 0002 was used to make the time to depth conversion.

We mapped a total of five horizons related to the submarine fan (Hz1 – fan base; Hz2 – lower fan; Hz3 – middle fan; Hz4 – upper fan; Hz5 – fan top). For Hz1 we applied the Coherence seismic attribute with 28, -28 ms window to highlight the slope, faults and substrate irregularities. On Hz2-5 we applied the Spectral Decomposition seismic attribute, set up with continuous-wavelet transform (CWT), Gaussian wavelet and 41.5 Hz output frequency, to illuminate channel network.

RESULTS

- INTERPRETED HORIZONS

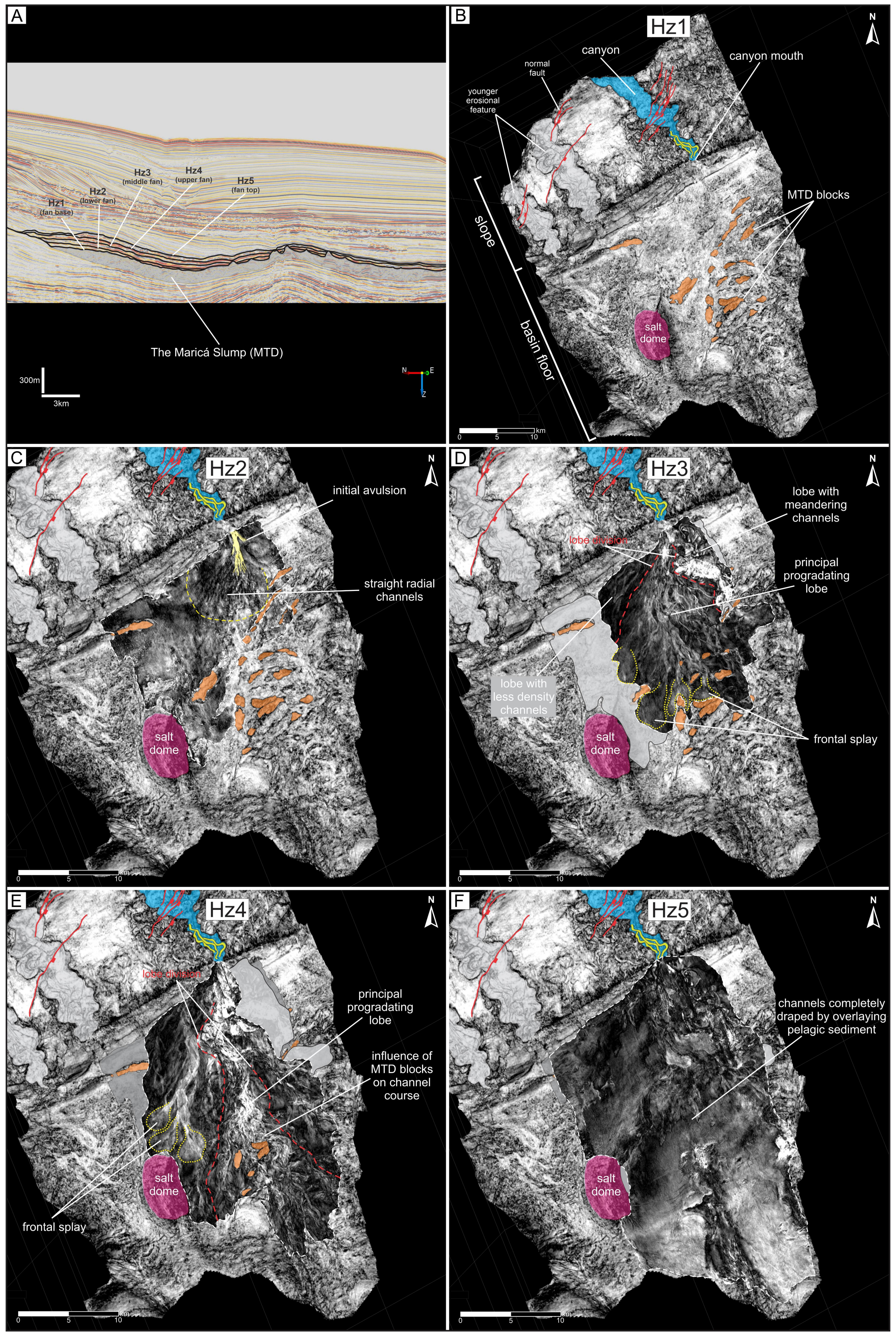

Figure 2: A) Inline seismic view with the position of each horizon. B) Hz1 – fan base. The submarine fan is fed by one principal canyon and the previous MTD creates some irregularities on the surface. C) Hz2 – lower fan. This is the first stage of the fan development. D) Hz3 – middle fan. The development of the submarine fan. E). Hz4 – upper fan. The complete development of the submarine fan with strong progradation towards the basin. F) Hz5 – fan top. The end of the submarine fan activity.

- ISOCHRON MAPS

The isochron maps confirm the influence of the MTD blocks on the submarine fan deposits molding a fan shape extended on the direction N-S. (Fig. 3 A-D).

Looking at the isochron maps between horizons it is possible to identify a stage of lateral compensation that happen between Hz2 and Hz3 (Fig. 3 F).

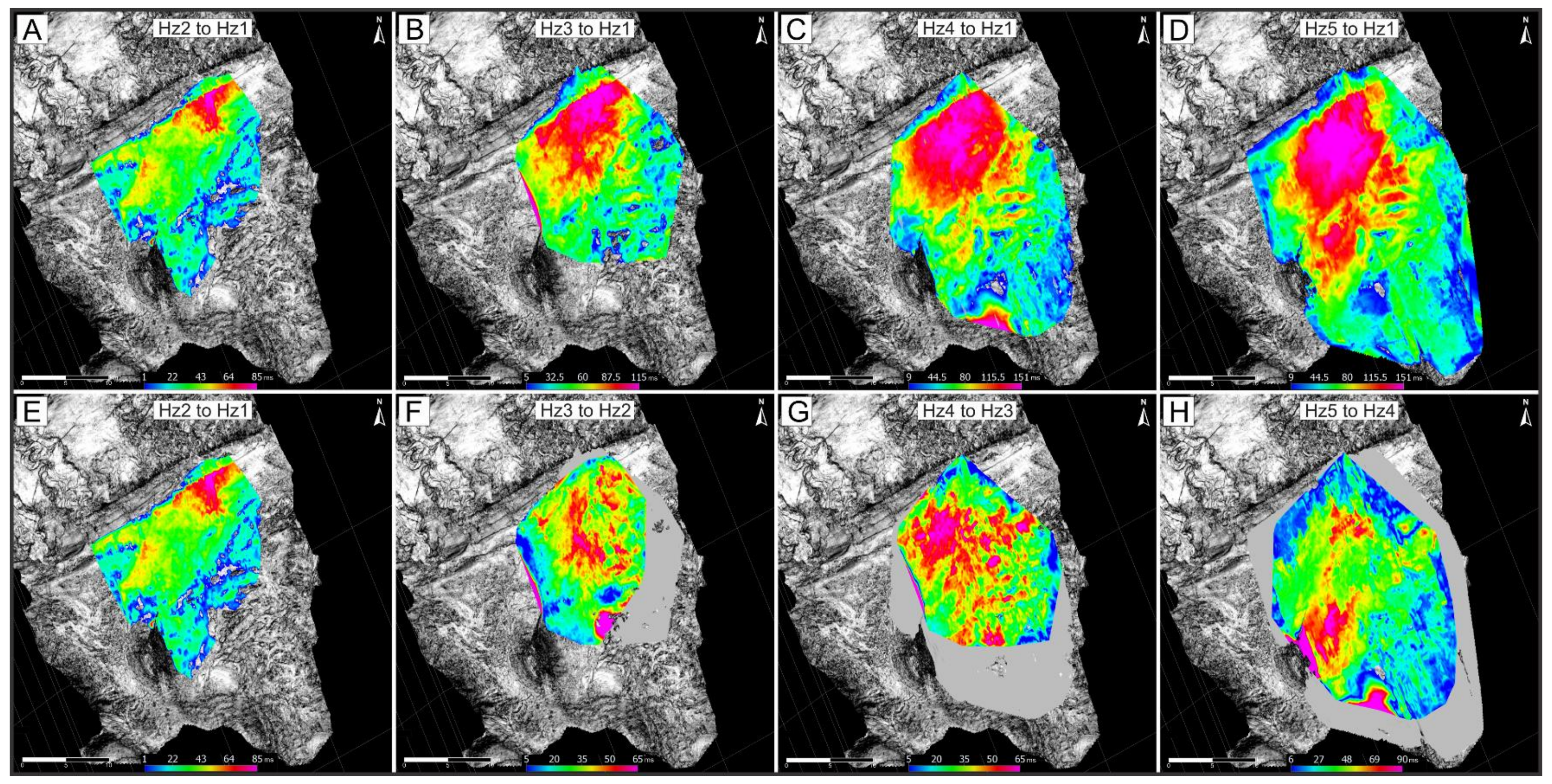

Figure 3: A-D) Isochron maps of accumulative growth of the submarine fan measured from the horizons to the base (Hz1). E-H) Isochron maps showing growth pattern between horizons.

- CHANNEL SINUOSITY

The sinuosity index (SI) was measured on a planform view dividing the channel length by the channel ends distance. We measured 113 channels and classified them as straight (sinuosity < 1.1), sinuous (1.1 < sinuosity > 1.5) and meandering (sinuosity > 1.5). Dada show that channel sinuosity increases as the submarine fan grow, changing from 100% straight channels on Hz1 to 49% straight and 51% sinuous channels on Hz4 (Fig. 4).

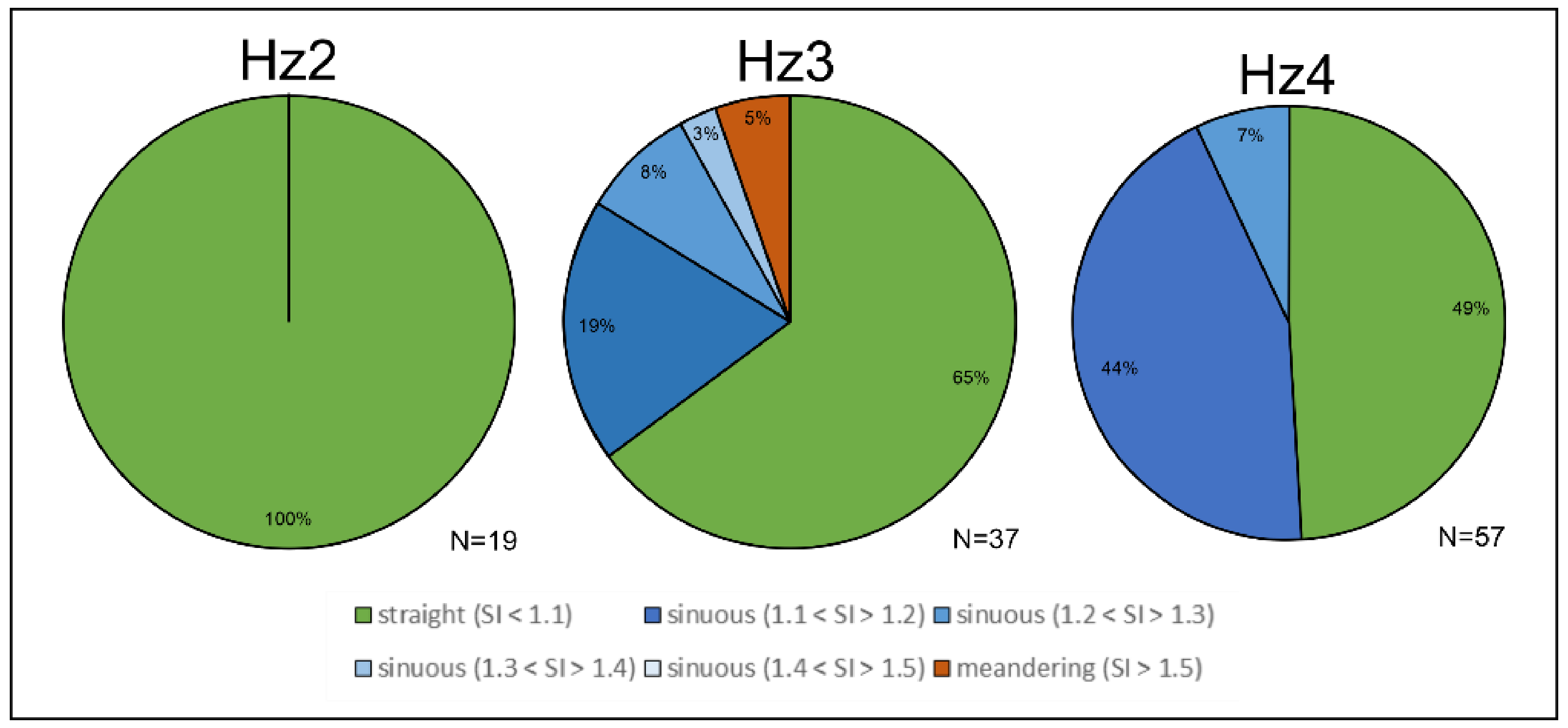

Figure 4: Graphic of sinuosity index measured on each horizon.

CONCLUSIONS AND FUTURE WORK

- We divide the fan in three different lobes based on channel pattern, sinuosity and channel density, and the difference on each horizon may be caused by the underlying topography.
- The geomorphological changes through the submarine fan growth allow to identify stages of lateral compensation (Hz3) and progradation (Hz4).
- As a next step we will look for declivity data to observe more closely the relationship between sinuosity and downlobe gradient. We will apply an Amplitude seismic attributes to help identify sandy deposits and their distribution on each horizon.

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