The Architecture and Evolution of a Delta-Canyon-Fan System: Insights from a Stratigraphic Forward Model in Perth Canyon, Western Australia

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1. Introduction

The sedimentation research in deep marine environment is poorly documented because of the difficult access and the uncertainty in the geophysical investigations of these systems. In this study three-dimensional stratigraphic forward modeling (SFM) is applied to simulate the integrated turbidity system from river mouth to abyssal basin via continent shelf and sinuous canyon in geological time scale in Perth Canyon, Western Australia. It aims to provide more information about the architecture and evolution of deepwater system.

2. Method and Input

LECODE (Landscape Evolution Climate Ocean and Dynamic Earth) was used to simulate the turbidity sedimentation. It combines the shallow water equation and diffusion method to get the balance between the computation efficiency and hydraulic features.

$$\frac{\partial A}{\partial t} = -\nabla \cdot (Au) = 0 \qquad \text{Continuity Equation}$$

$$\frac{Du}{Dt} = -g\nabla H + \frac{\mu}{\rho}\nabla^2 u - c\frac{u|u|}{h} \qquad \text{Momentum Equation}$$

$$(1-\lambda)\frac{\partial z_k}{\partial t} = \frac{\varepsilon \beta_t \omega_{sk}}{h}(c_k - c_k^*) \qquad \text{Exner Equation}$$

Table 1 The properties of sediment grains.

D (mm)	0.5	0.4	0.3	0.2	0.15	0.1	0.05	0.01	0.004	0.002
P (5)	4	6	8	13	17	19	14	9	6	4

Table 2 The input data

Sea level	-120 to 0 m
Concentration	35 Mt/y
Flow Discharge	4000 m^3/s
Velocity	2 m/s
Occurrence	50%
Cell number	105 × 200
Cell size	1000 × 1000 m
Layer interval	1 ky
Simulation period	150 ky

3. Results

(1) General characteristics

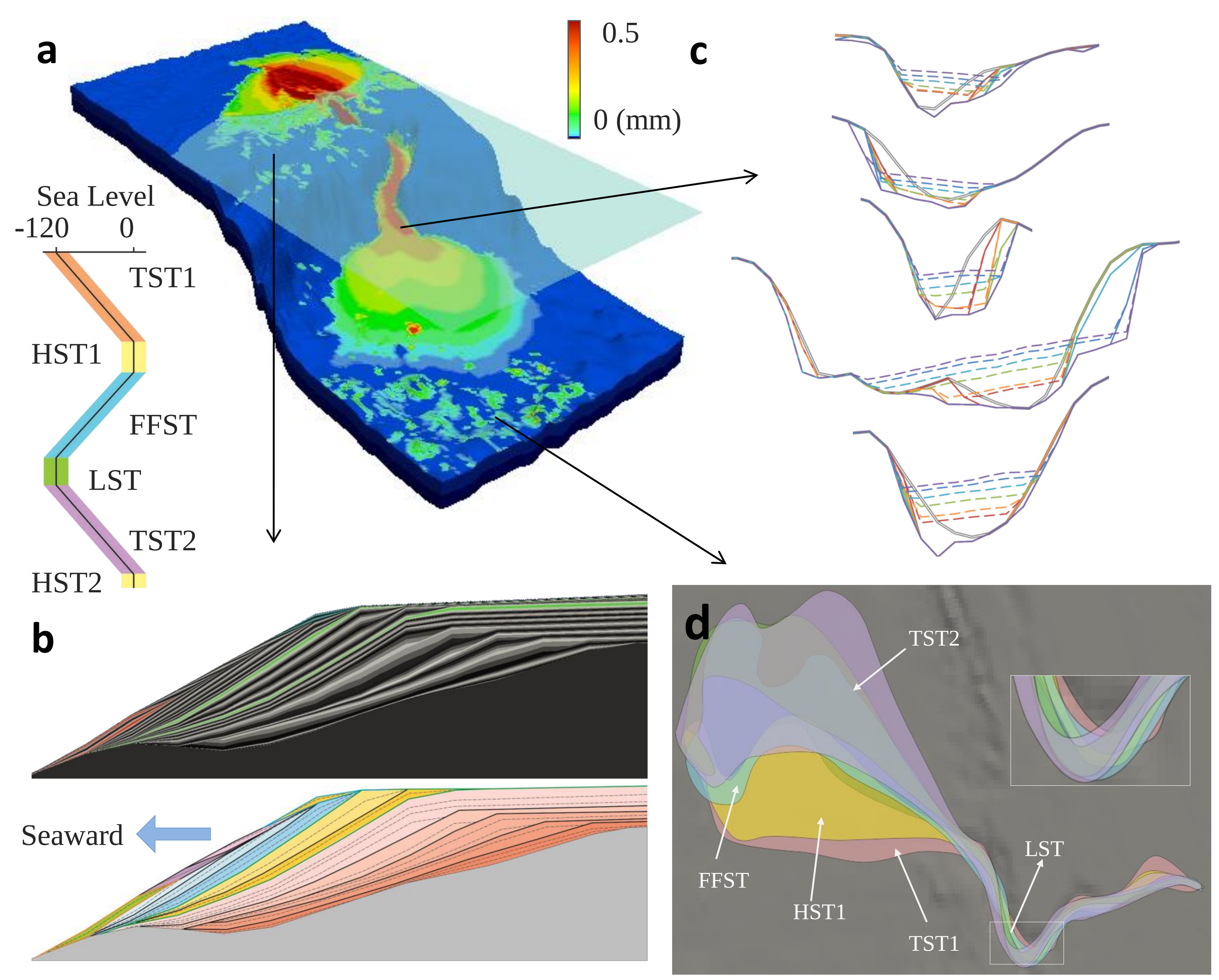

Figure 1 (a)The simulated grain size distribution in 150 ky. (b) The layer index and interpreted stratigraphic frame. (c) The canyon evolution. (d) The flow path area evolution.

(2) Deposition and erosion

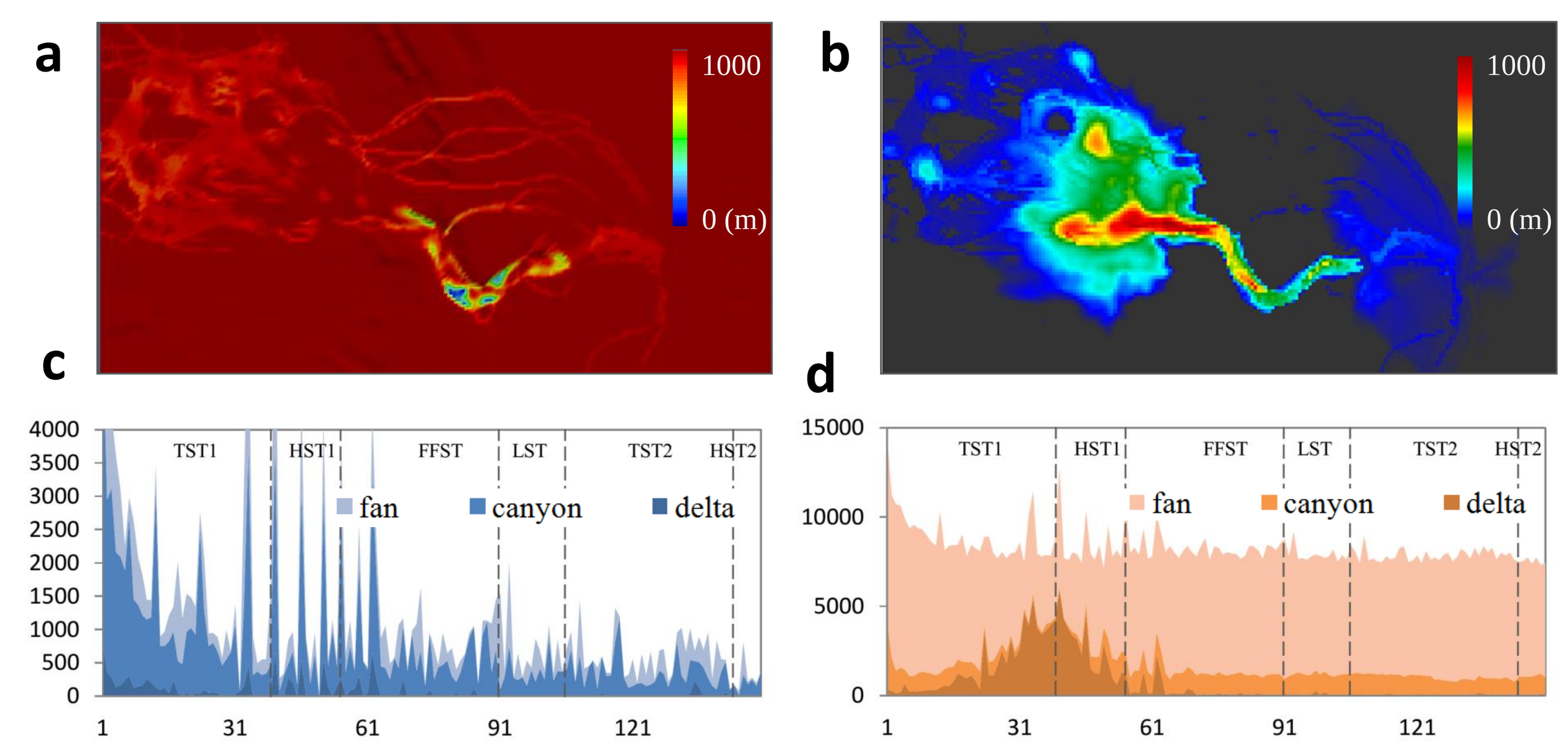

Figure 2 (a) The thickness of background layer. (b) The thickness of deposition. (c) The erosion volume evolution (m^3). (d) The deposition volume evolution (m^3).

(3) Comparison with literature data

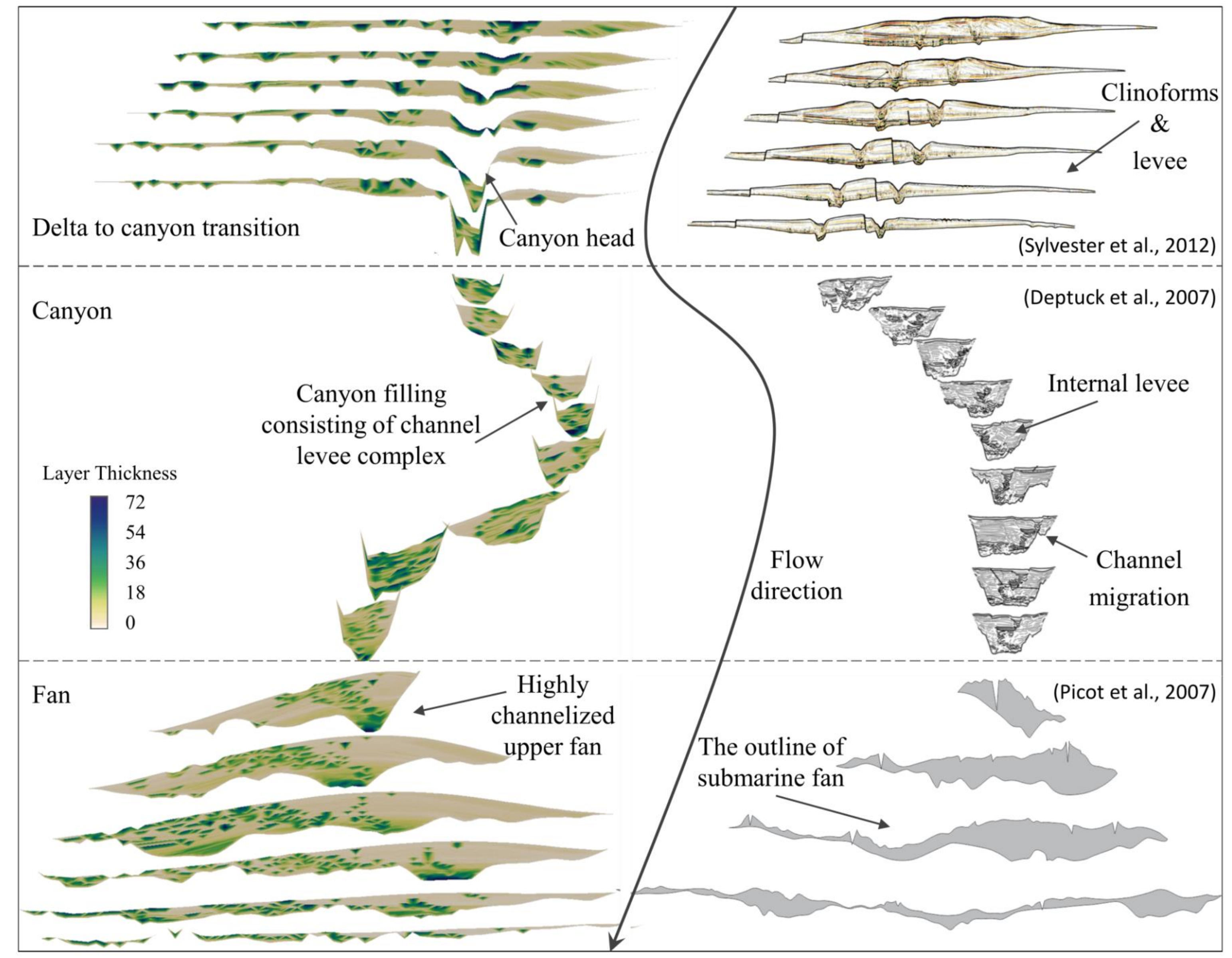

Figure 3 The comparison between the simulation results (left side) with actual data (right side).

4. Conclusions

1. The upper fan is the favorable reservoir because of thick coarse sediments and weak erosion.
2. Highstand systems tract (HST) is associated with fine sediments and embedded channels while Lowstand systems tract (LST) is associated with coarse sediments and amalgamated channels.
3. The direction of flow plays a critical role in eroding the inner banks of upstream canyon and the outer banks of the downstream canyon bend.

5. References

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