MAKING OF CREDIBLE PERMEABILITY MAPS OF HYDROGEOLOGICAL MODEL OF LATV IA

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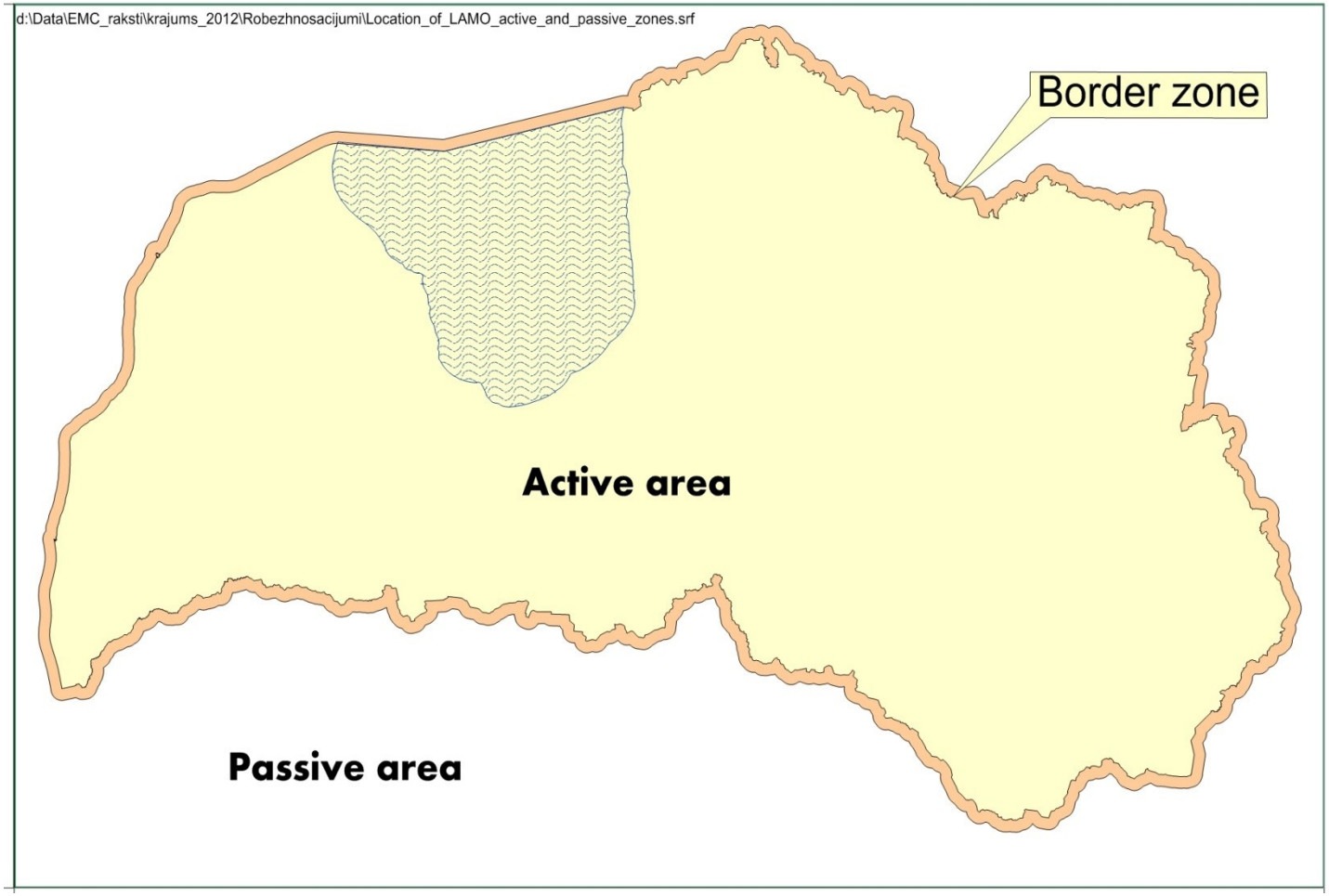
ECMS'16
30TH EUROPEAN CONFERENCE ON MODELLING AND SIMULATION

Introduction

1. LAMO v.4 regional HM of Latvia with 1901x1201x27 nodes, running on GV.
2. Refined hydraulic conductivity value for each node.

Location of LAMO

Active/Passive area



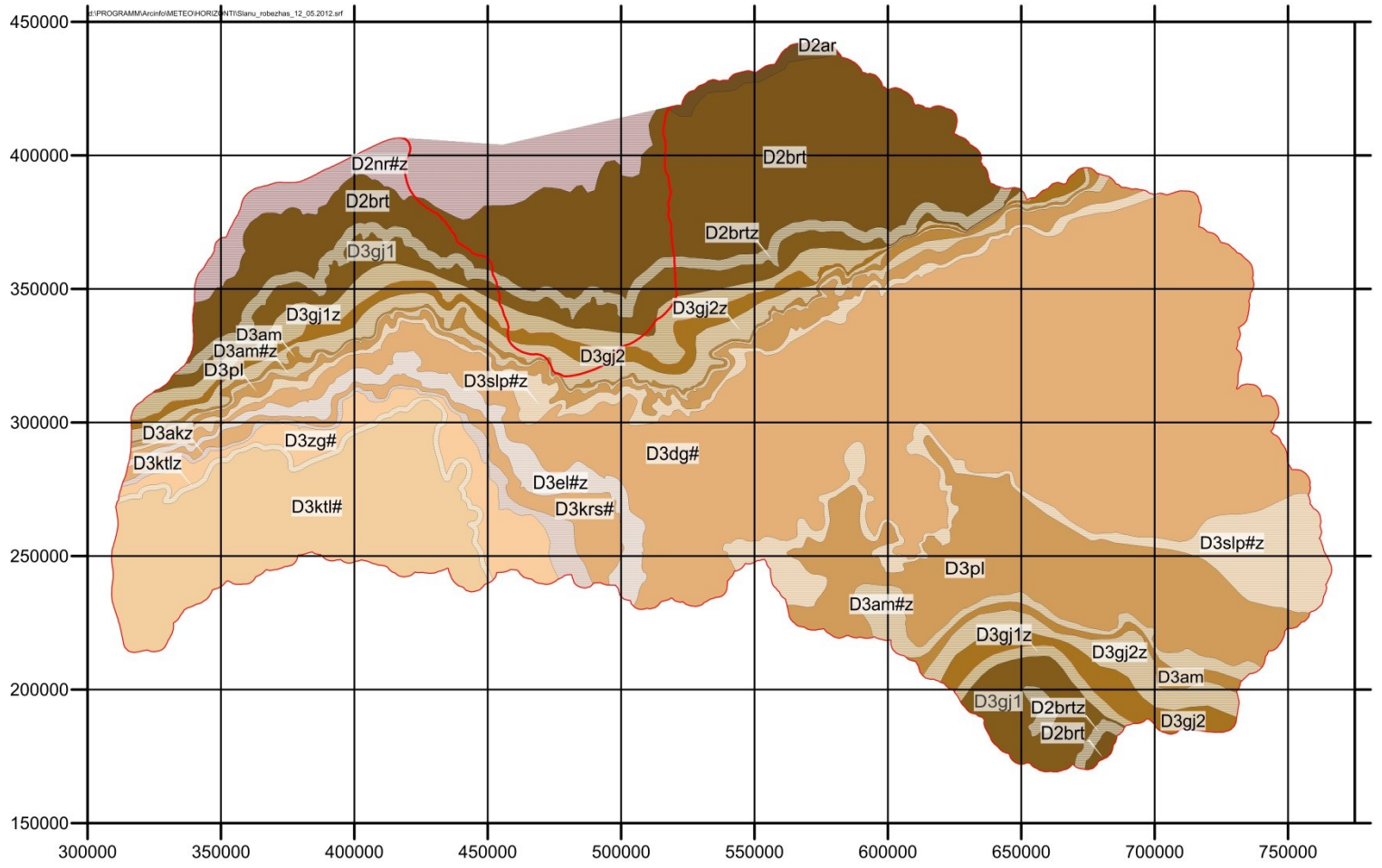
Vertical schematization of LAMO4

No of HM layer	*	Name of layer	HM layer code	Area, [thous. km^2]	m_{mean}, [meter]	k_{mean} [meter /day]
1		Relief	relh	71.29	0.02	10.0
2		Aeration zone	aer	71.29	0.02	3.1×10^{-6}
3		Unconfined Quaternary	Q2	71.29	5.77	11.2
4		Upper moraine	gQ2z	71.29	22.20	1.4×10^{-3}
5		Confined Quaternary	Q1#	7.4	6.13	7.0
6		Lower moraine	gQ1#z	9.7	9.3	2.8×10^{-4}
7		Ketleru	D3ktl#	5.32	61.46	4.2
8		Ketleru	D3ktlz	5.79	10.52	2.8×10^{-4}
9		Zagares	D3zg#	7.43	42.65	7.0
10		Akmenes	D3akz	7.95	11.05	2.8×10^{-5}
11		Kursas	D3krs#	9.34	22.34	6.3
12		Elejas	D3el#z	9.24	27.58	2.8×10^{-5}
13		Daugavas	D3dg#	32.14	30.37	9.4
14		Salaspils	D3slp#z	35.78	12.67	8.4×10^{-4}
15		Plavinu	D3pl	43.80	22.76	8.6
16		Amatas	D3am#z	45.14	8.97	1.4×10^{-4}
17		Amatas	D3am	46.21	21.91	6.4
18		Upper Gauja	D3gj2z	48.80	11.62	2.8×10^{-4}
19		Upper Gauja	D3gj2	50.92	26.34	6.2
20		Lower Gauja	D3gj1z	53.11	13.17	2.8×10^{-4}
21		Lower Gauja	D3gj1	56.13	31.55	5.4
22		Burtnieku	D2brtz	58.09	15.41	5.6×10^{-4}
23		Burtnieku	D2brt	68.74	45.02	4.2
24		Arikula	D2arz	68.74	15.02	4.2×10^{-4}
25		Arikula	D2ar	68.74	40.03	3.2
26		Narva	D2nr#z	71.29	116.67	2.8×10^{-5}
27		Pernava	D2pr	71.29	25.00	10.0

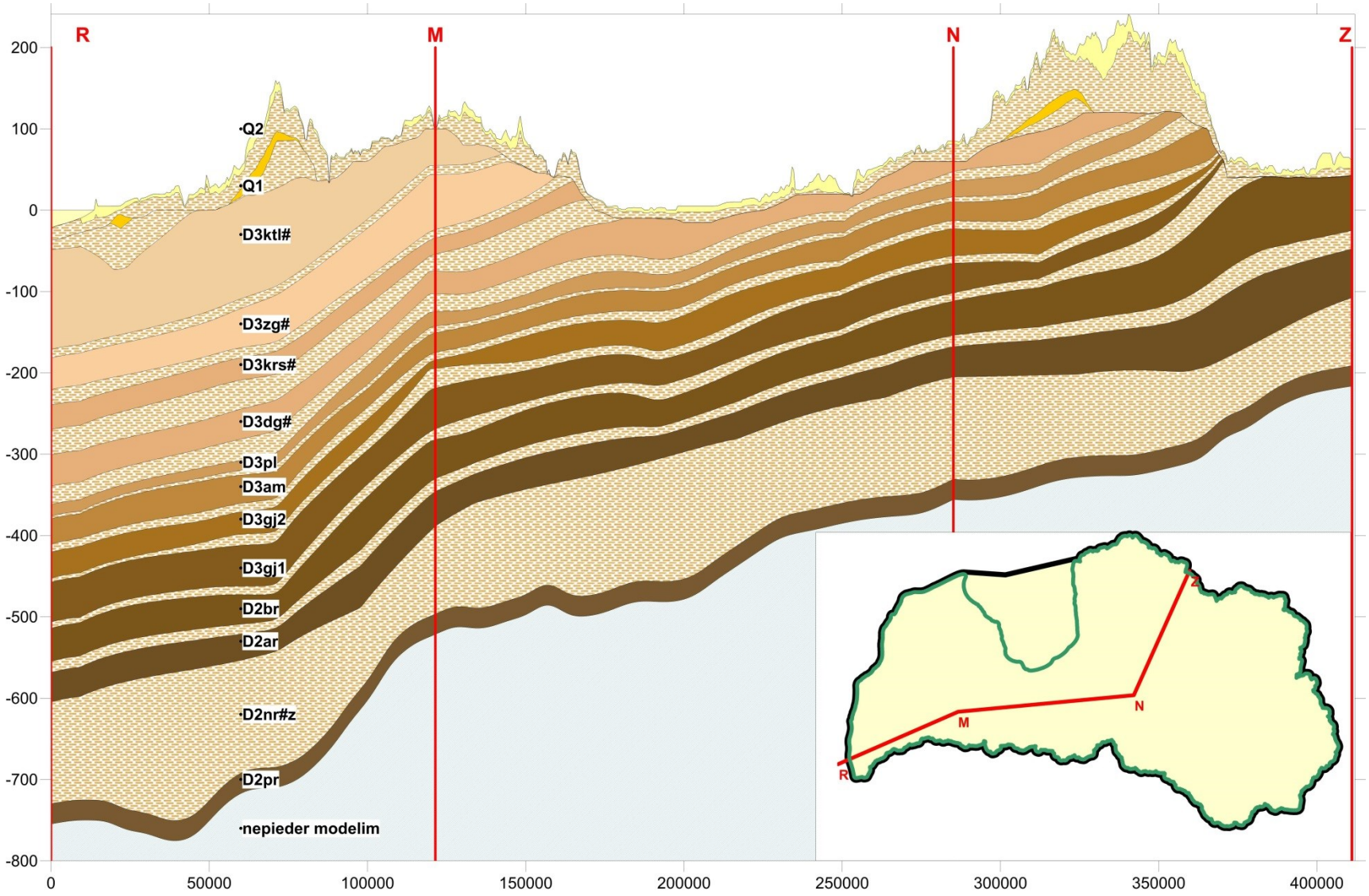
* - aquitard

m_{mean} and k_{mean} – the mean thickness and permeability

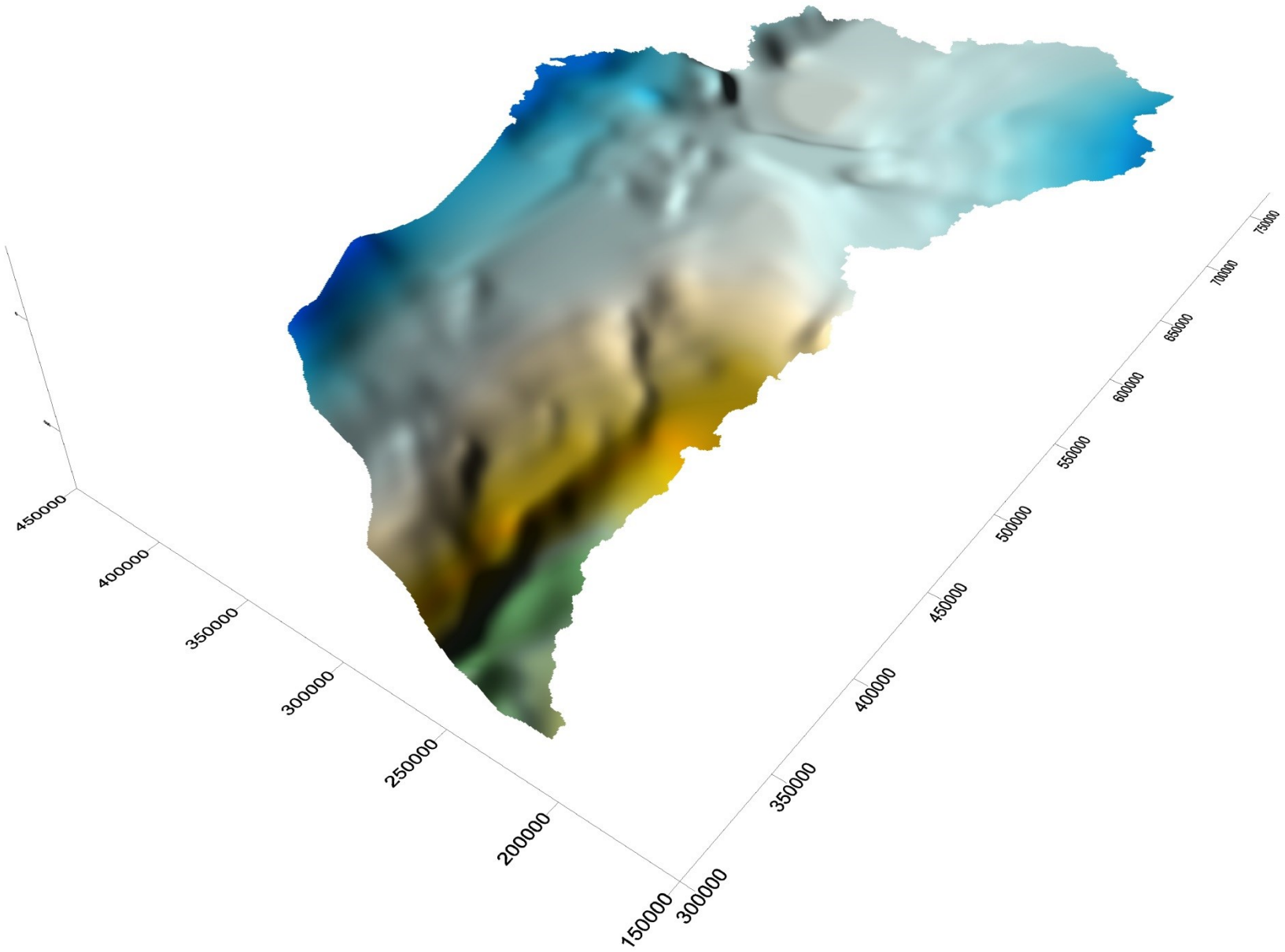
Boundaries of primary geological strata



Geological cross section



LAMO elevation 3D surfaces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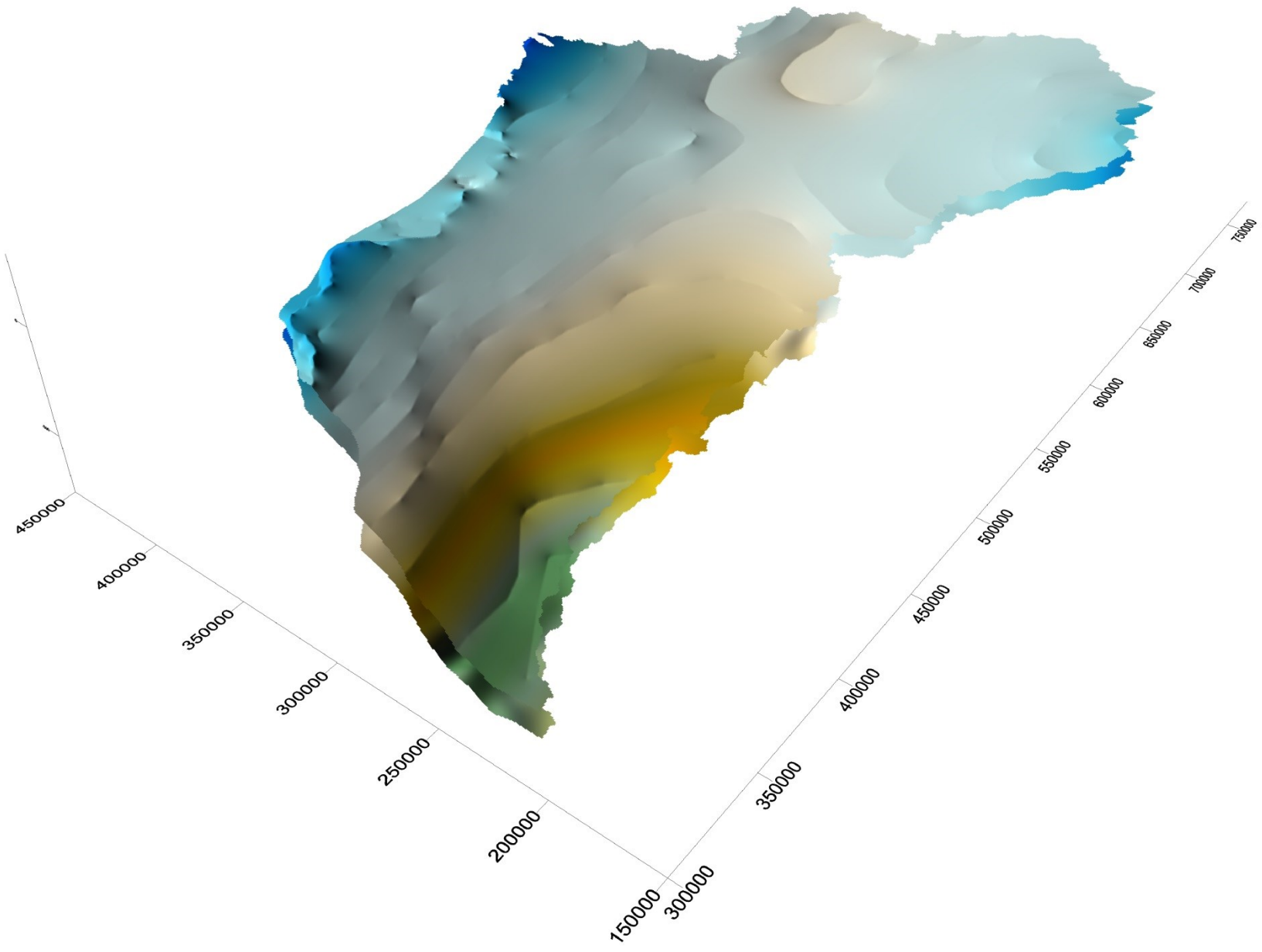
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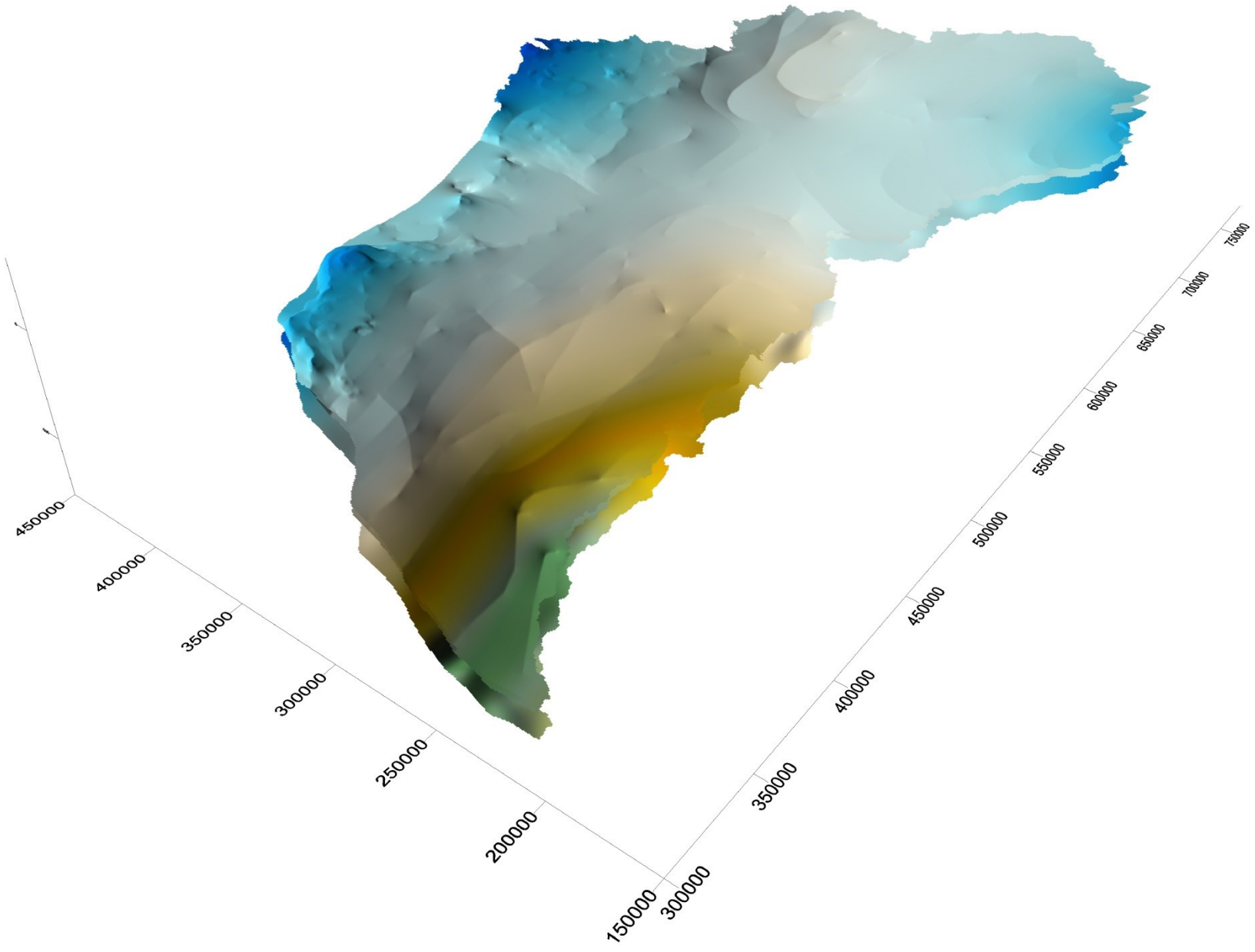
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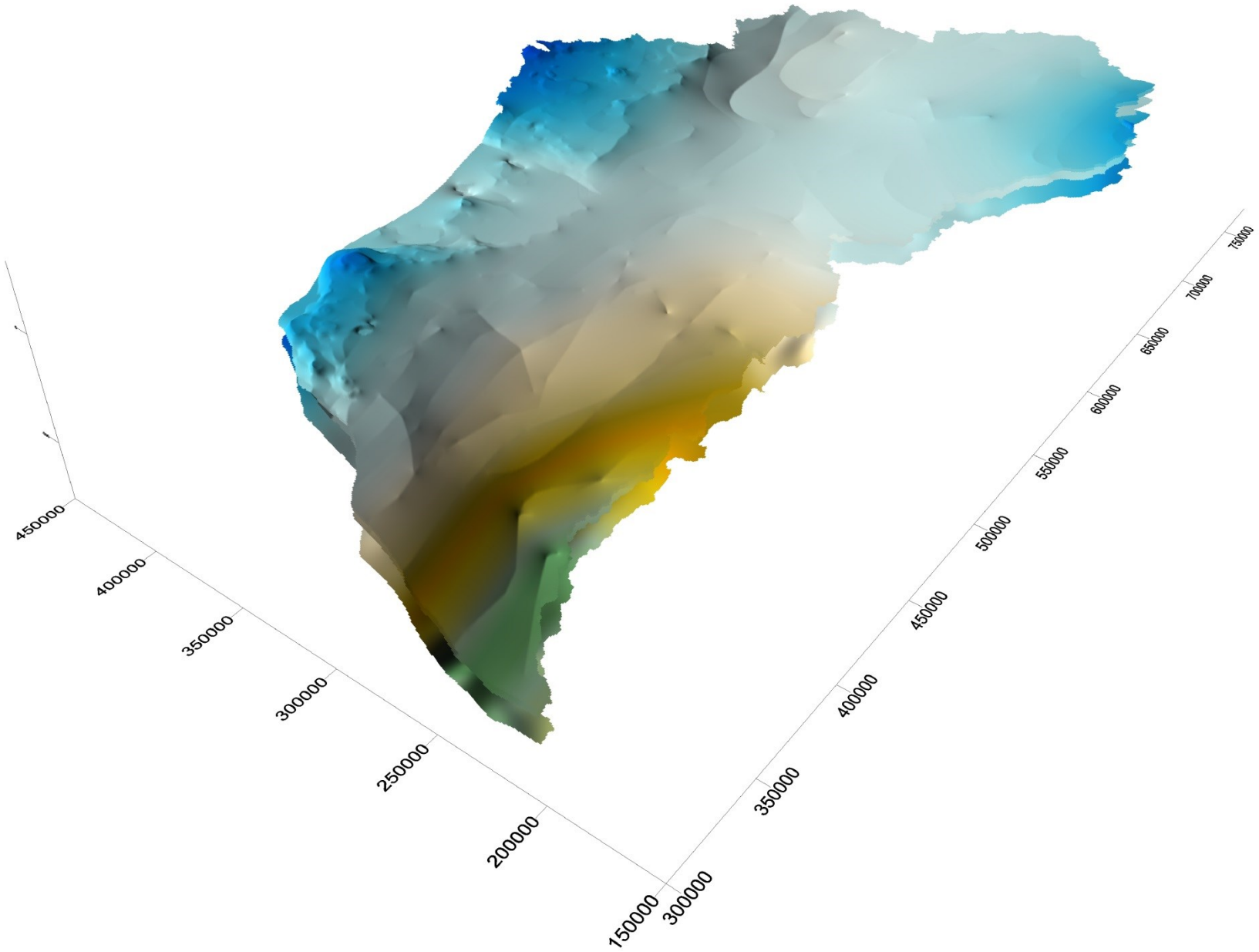
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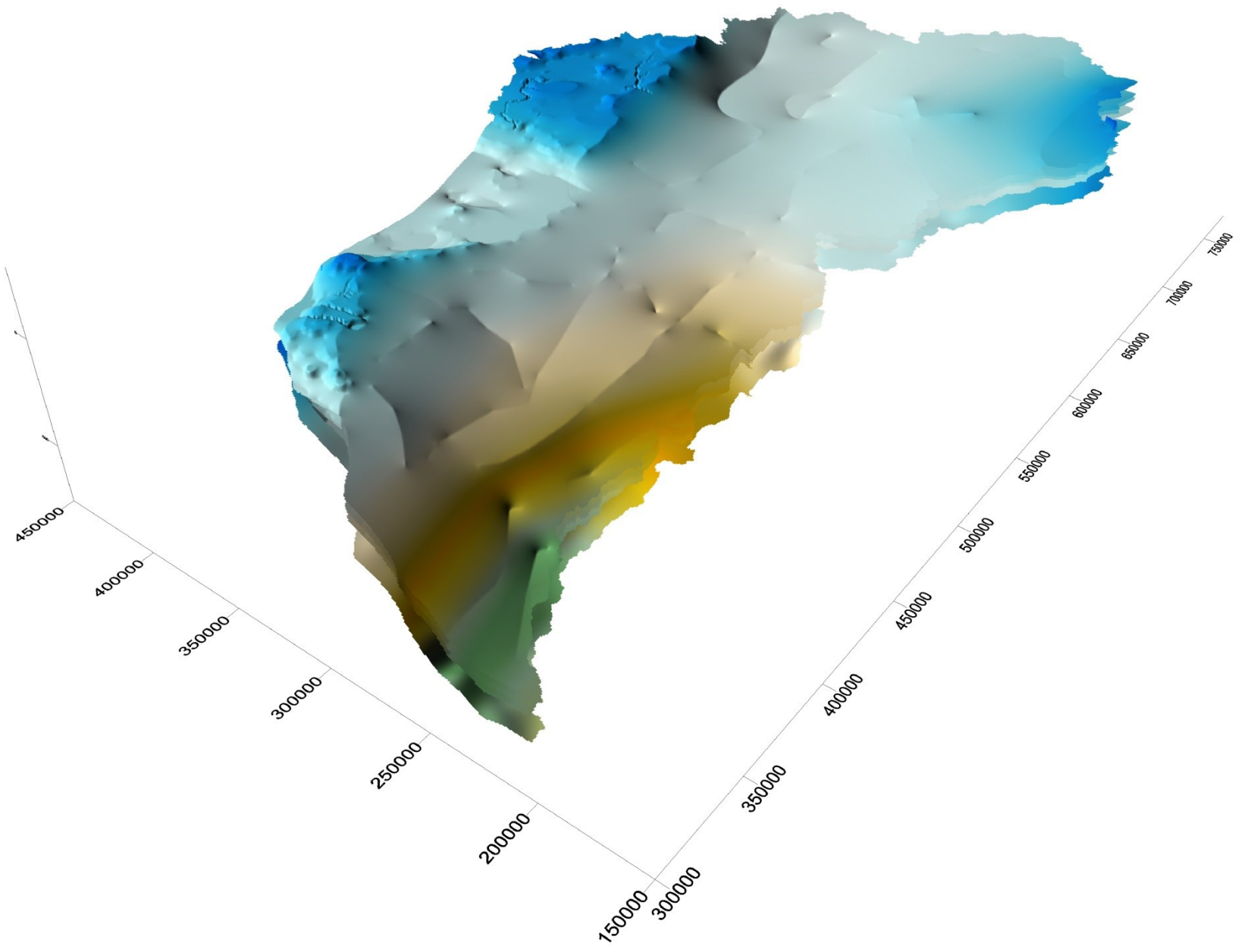
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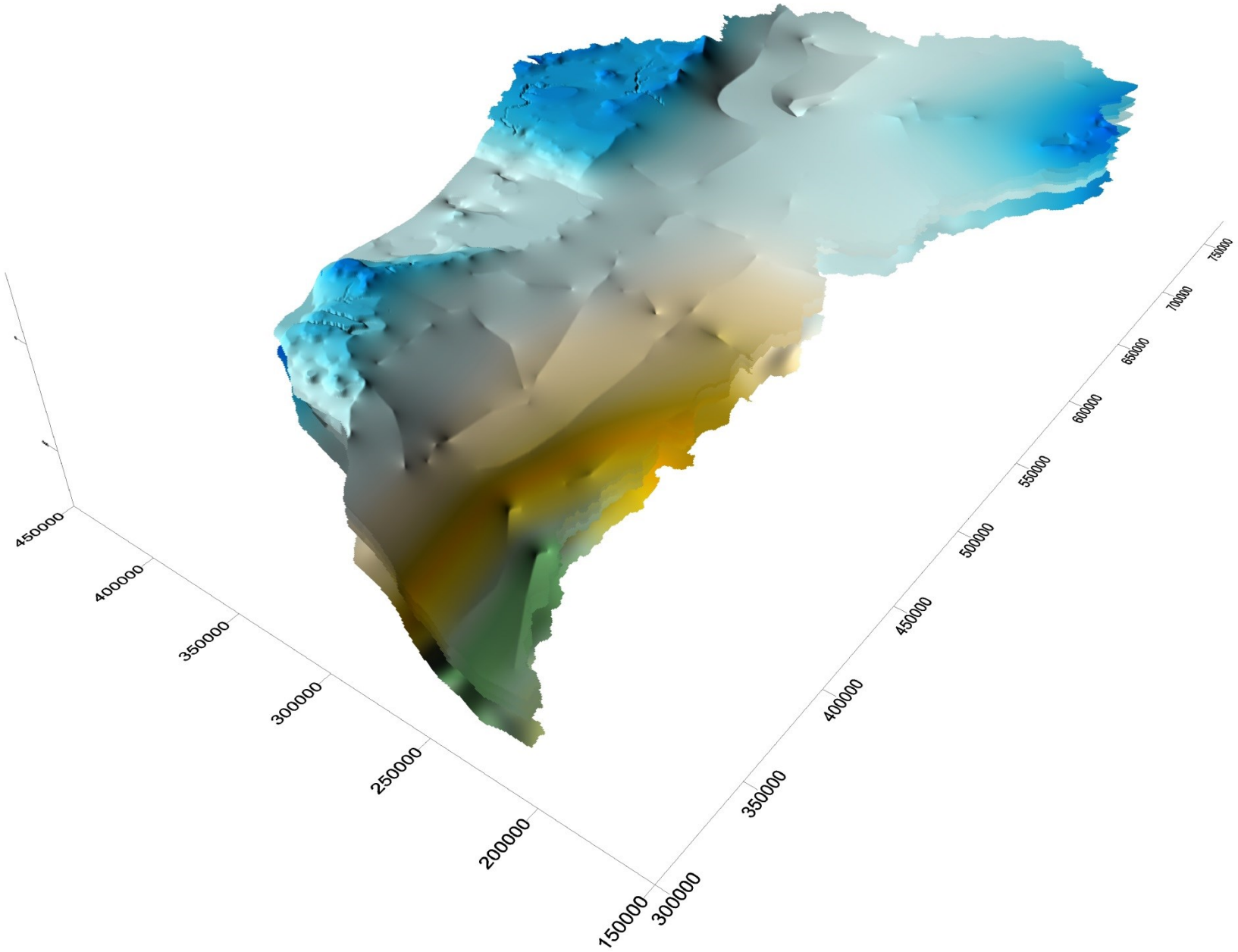
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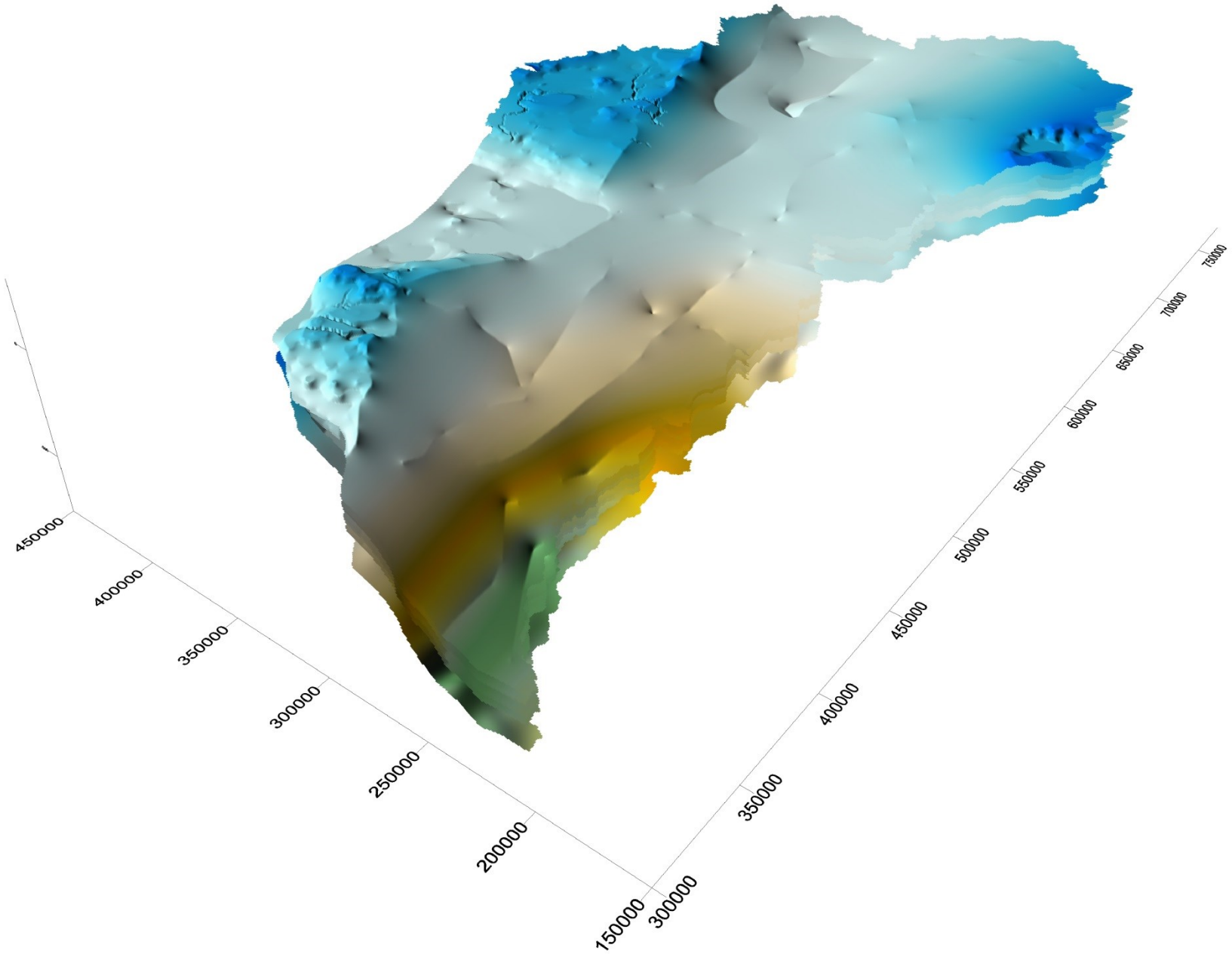
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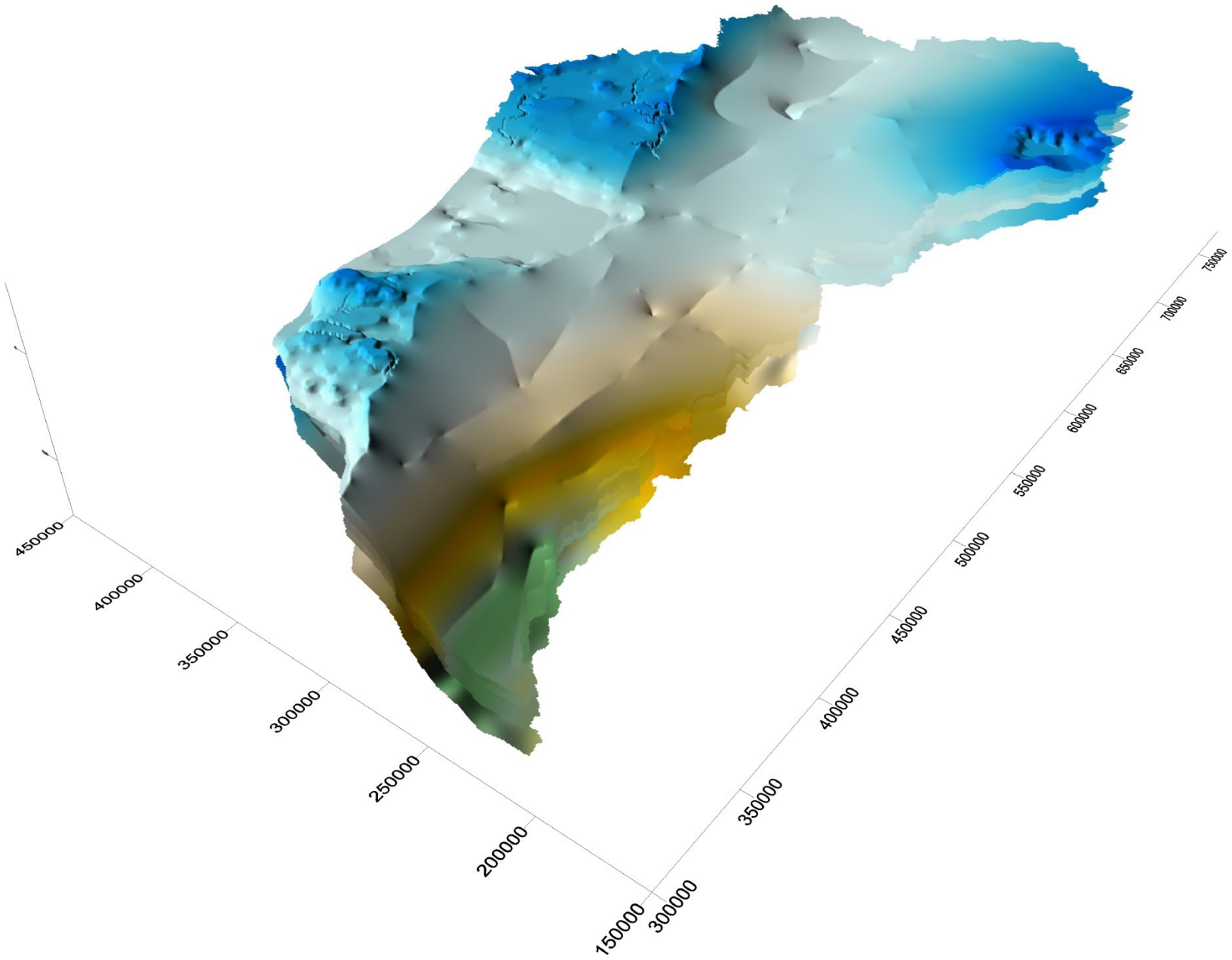
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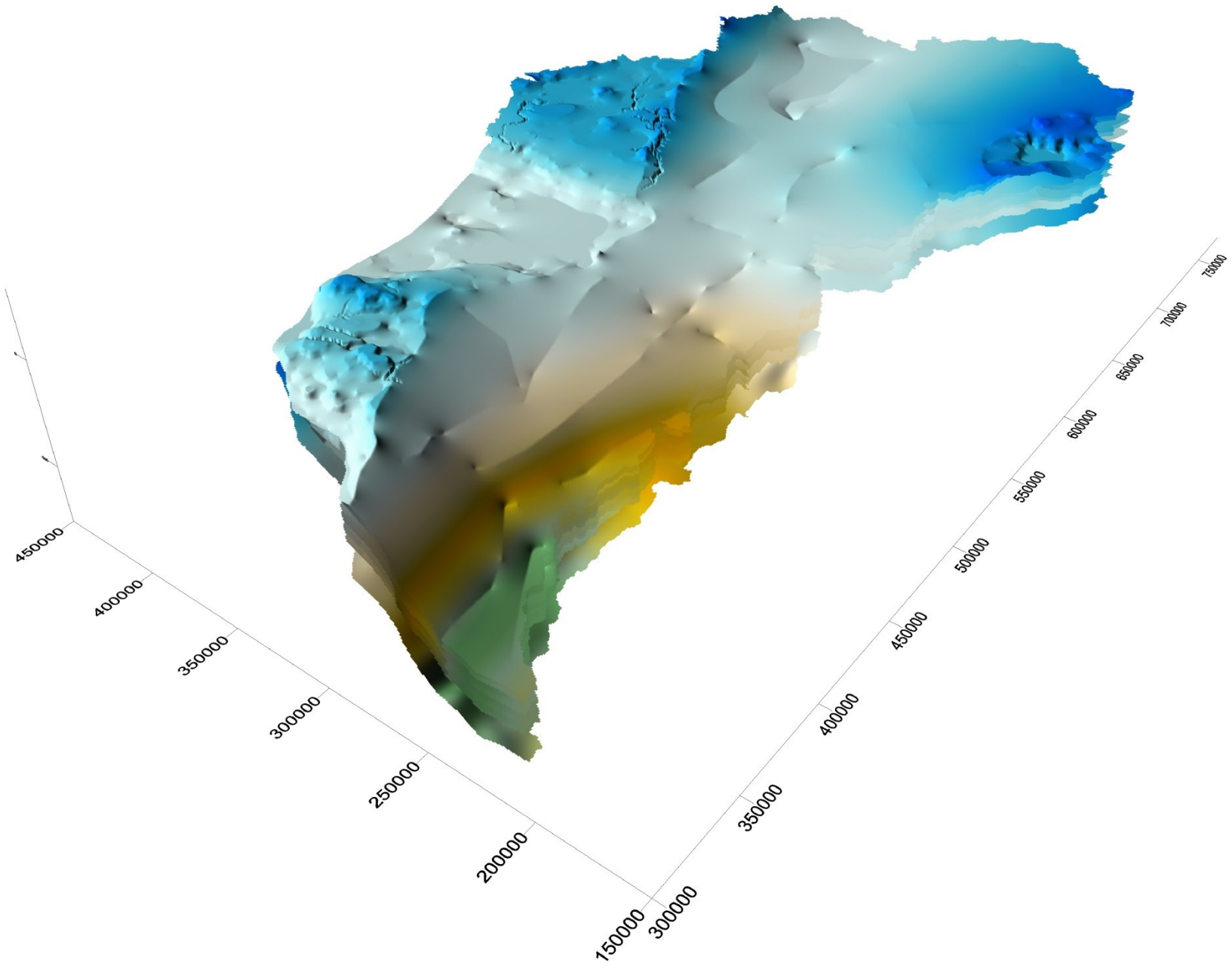
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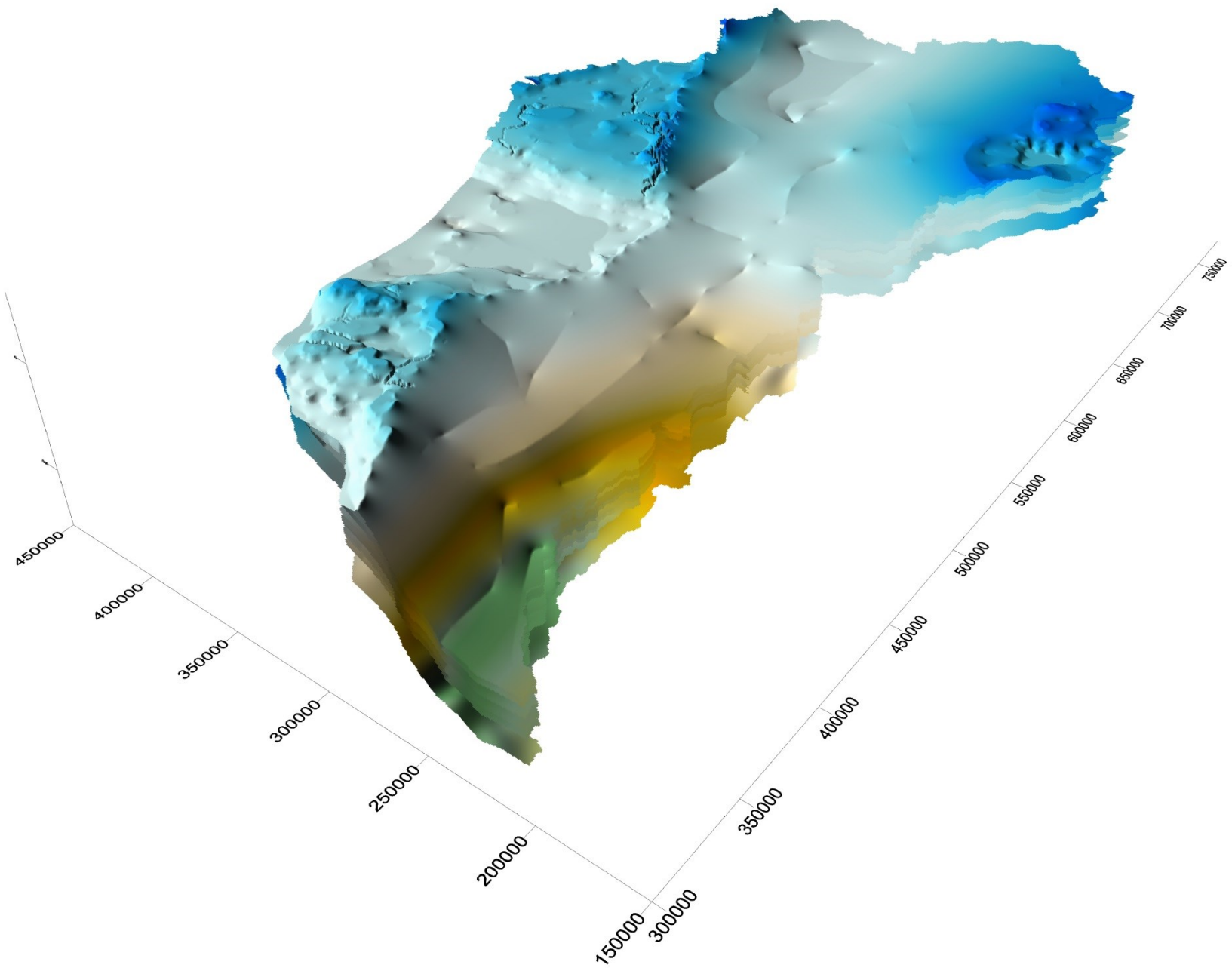
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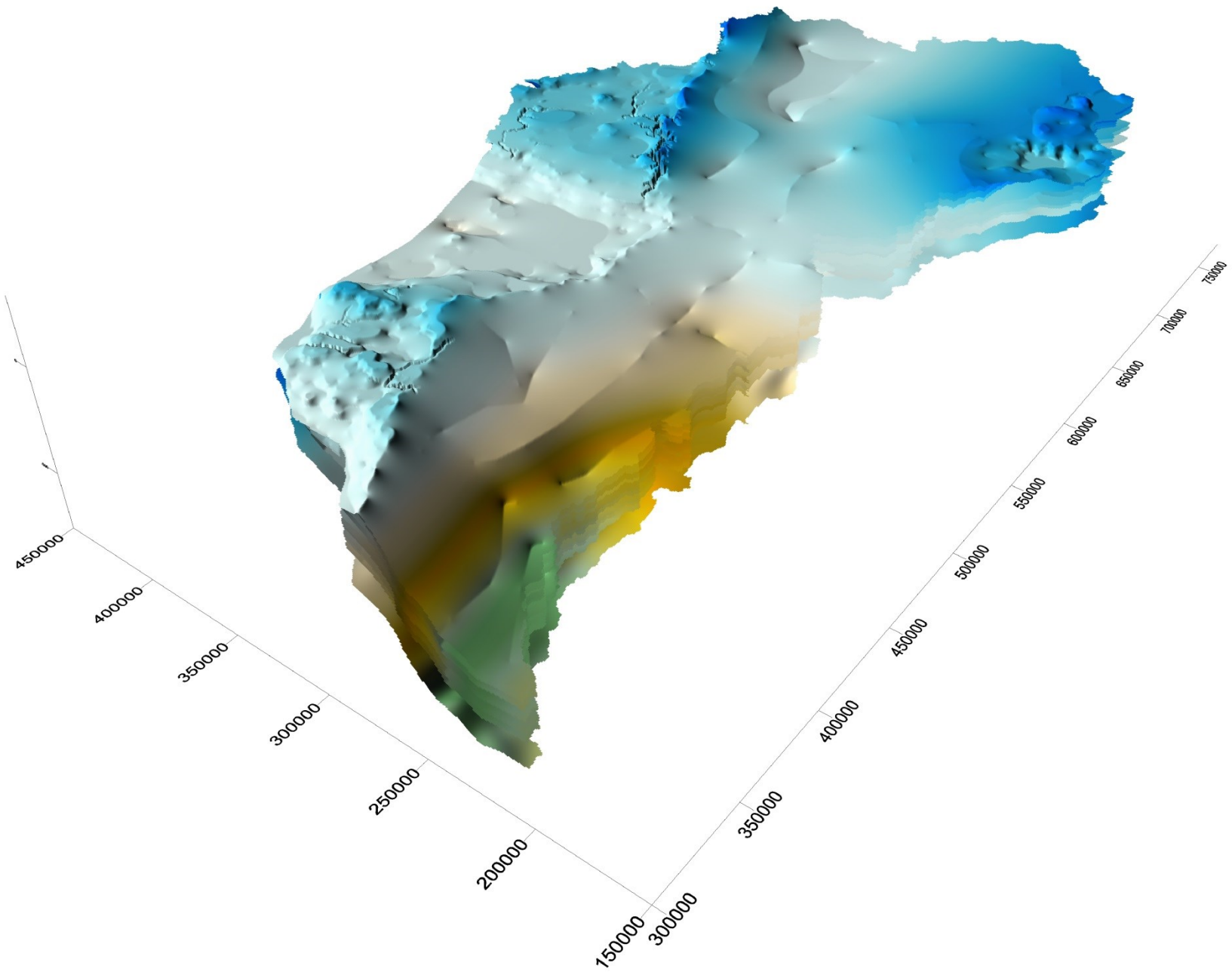
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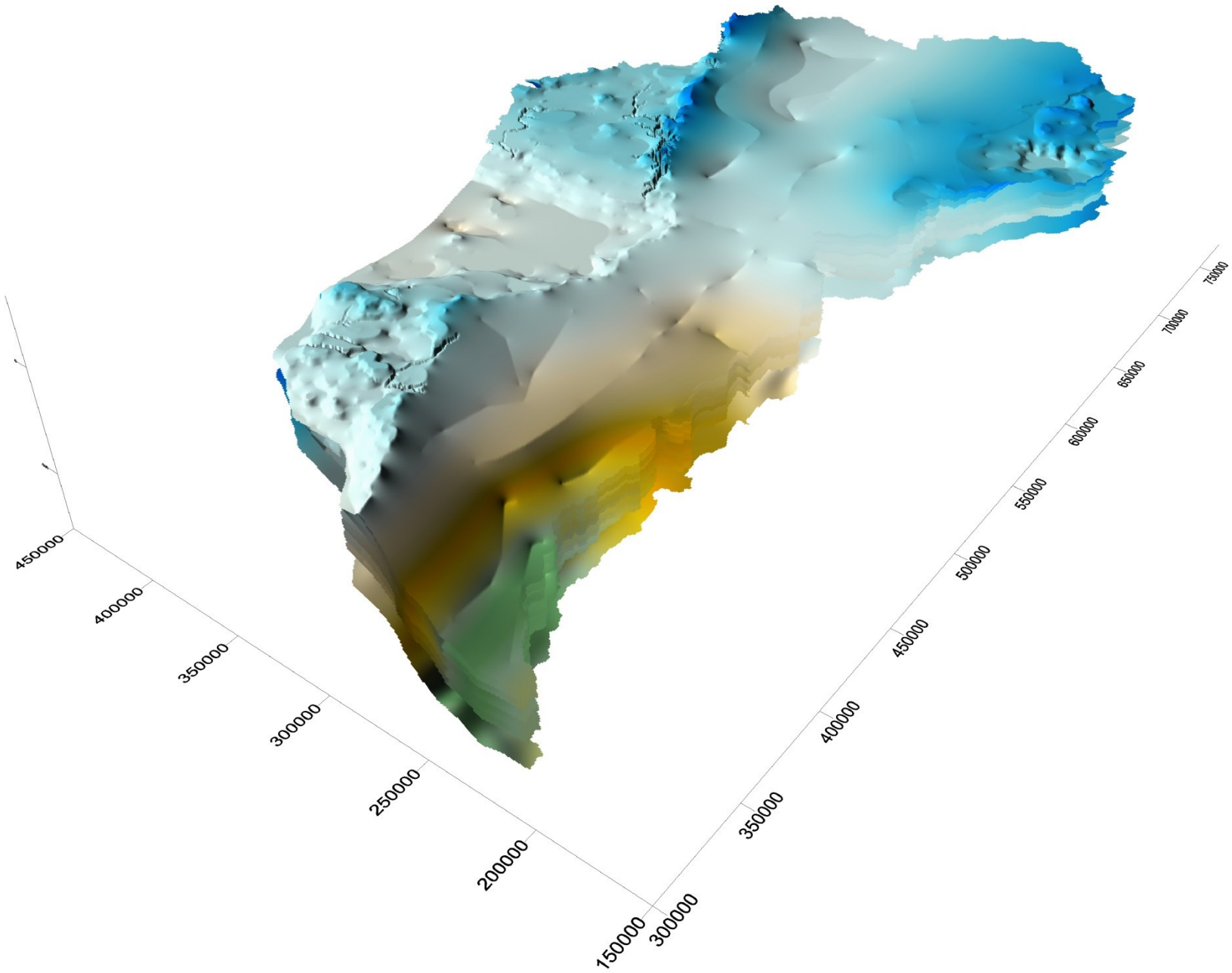
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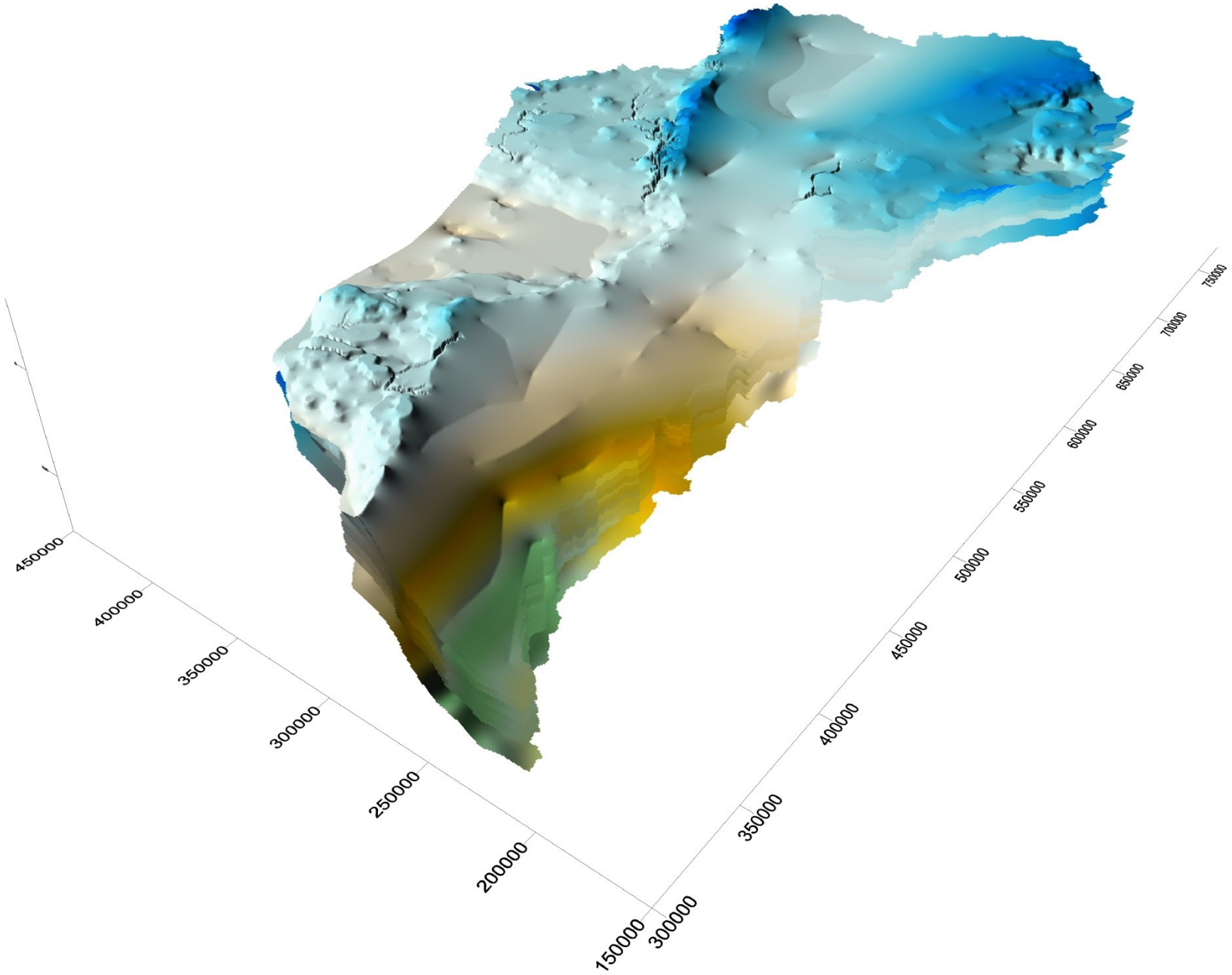
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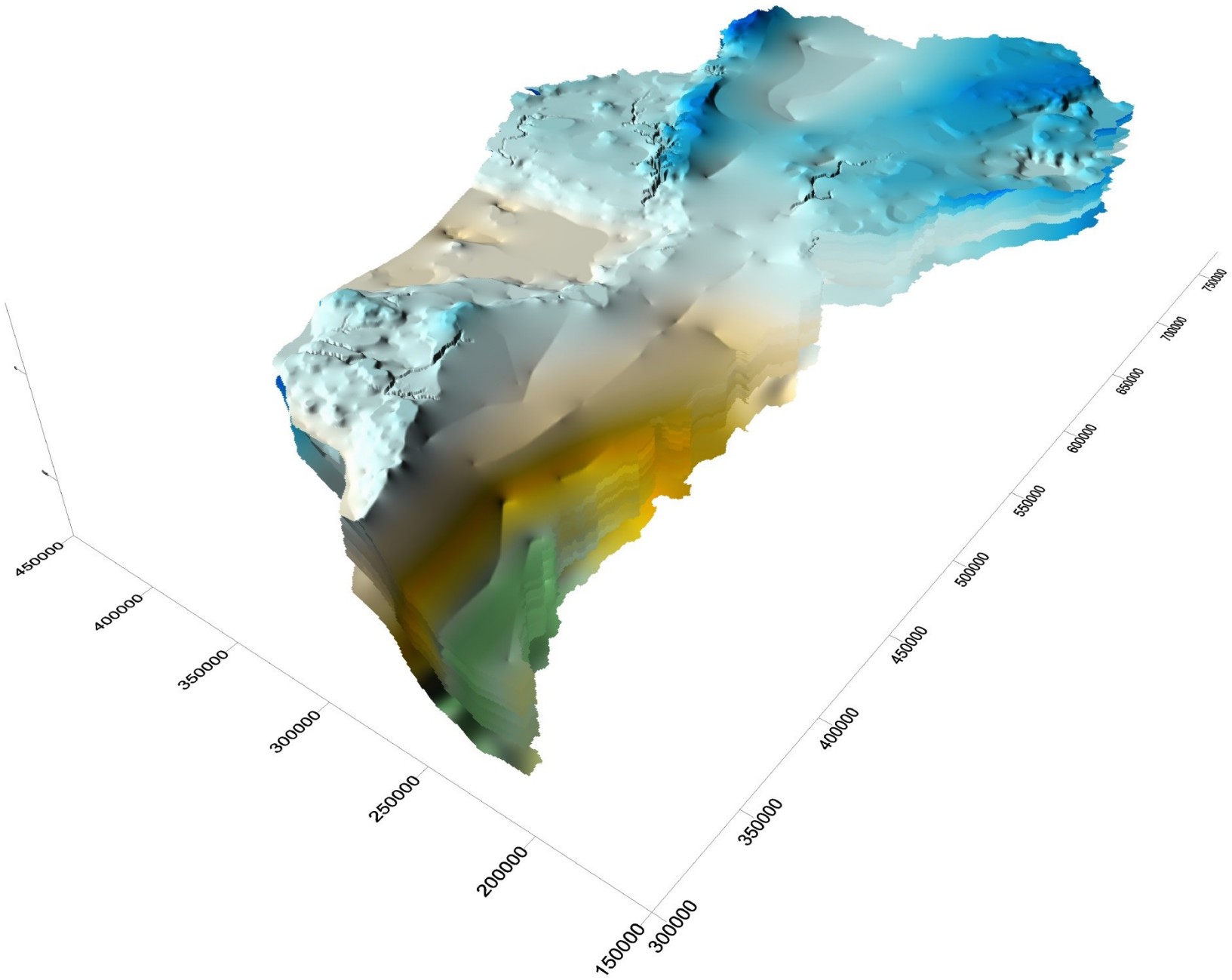
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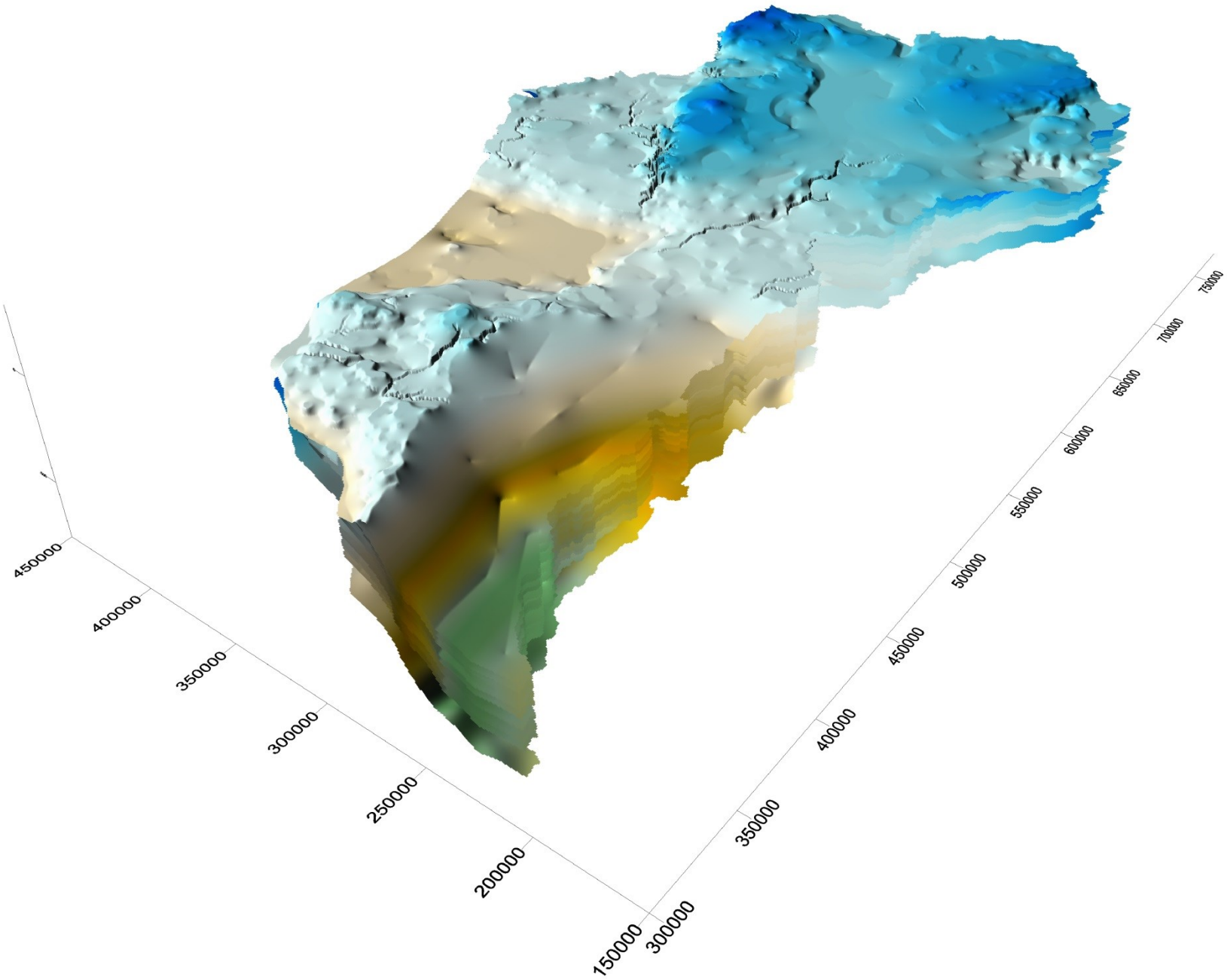
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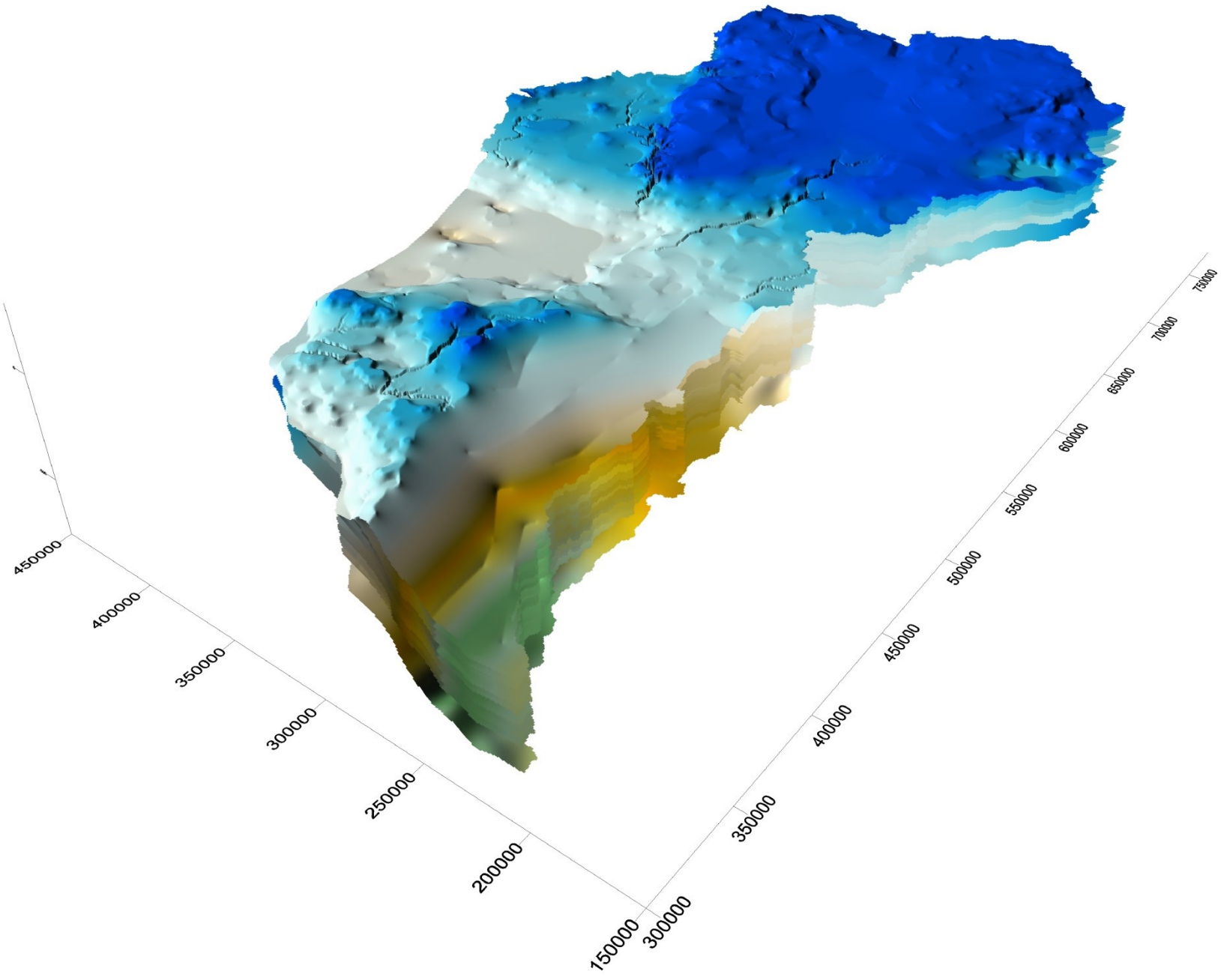
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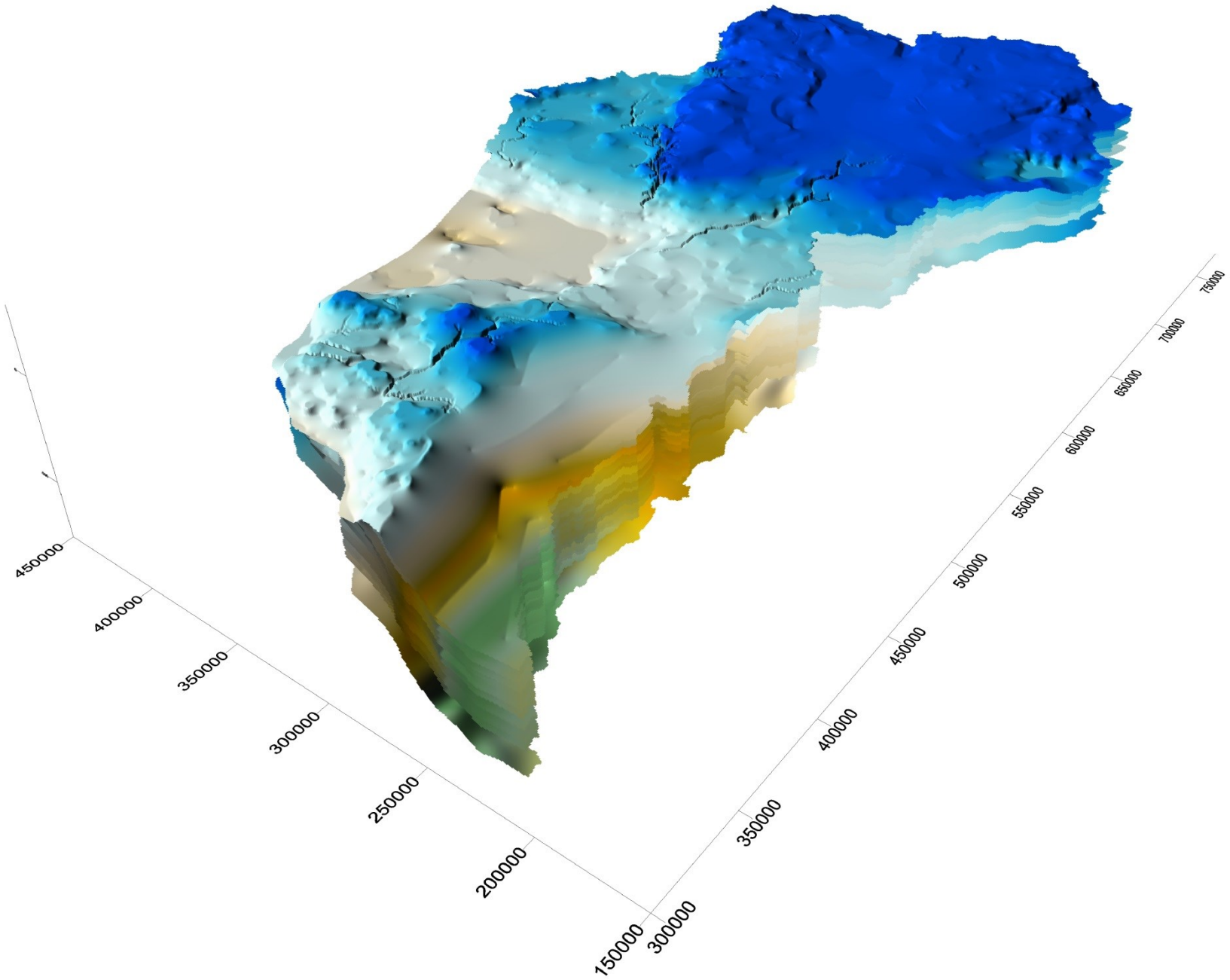
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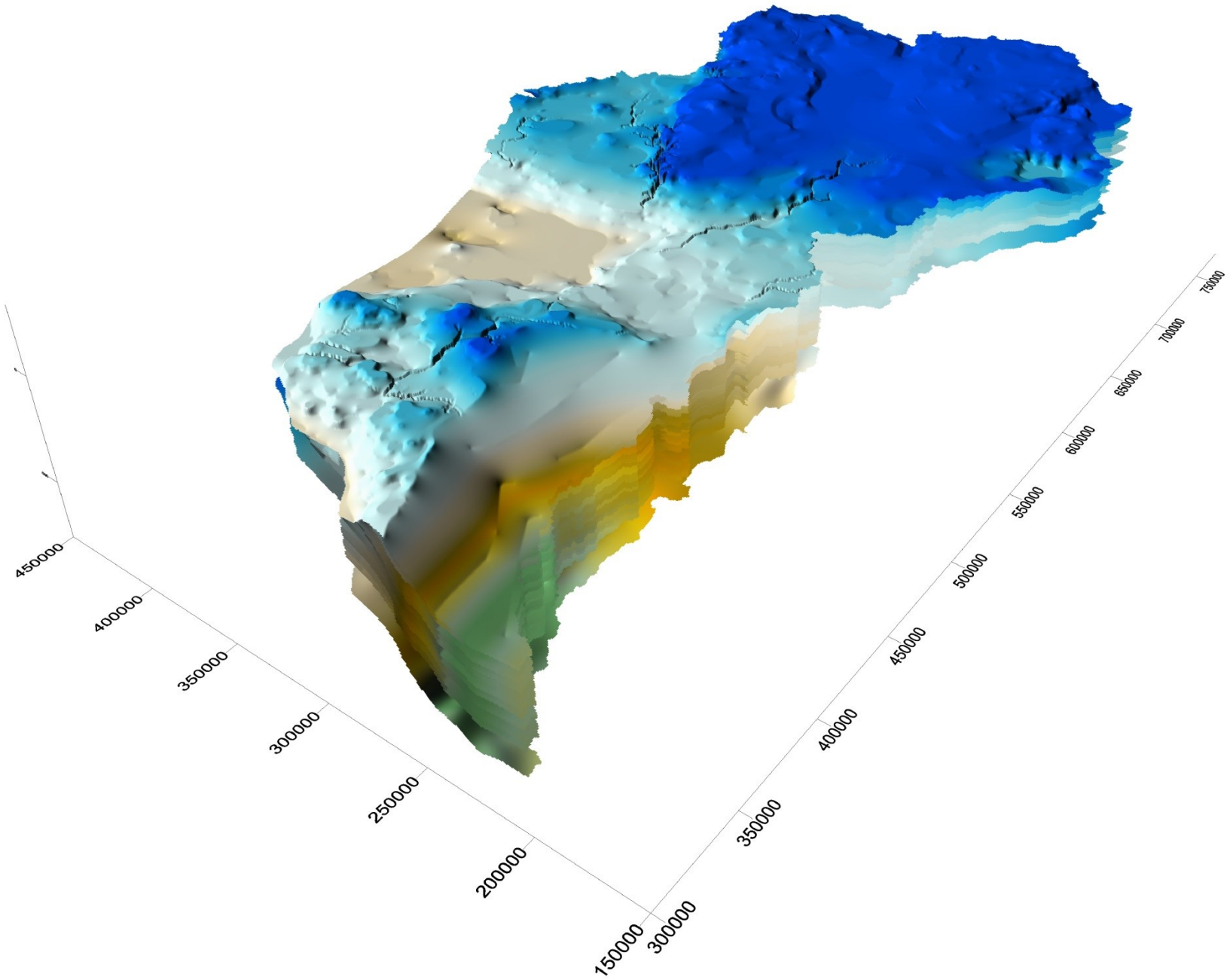
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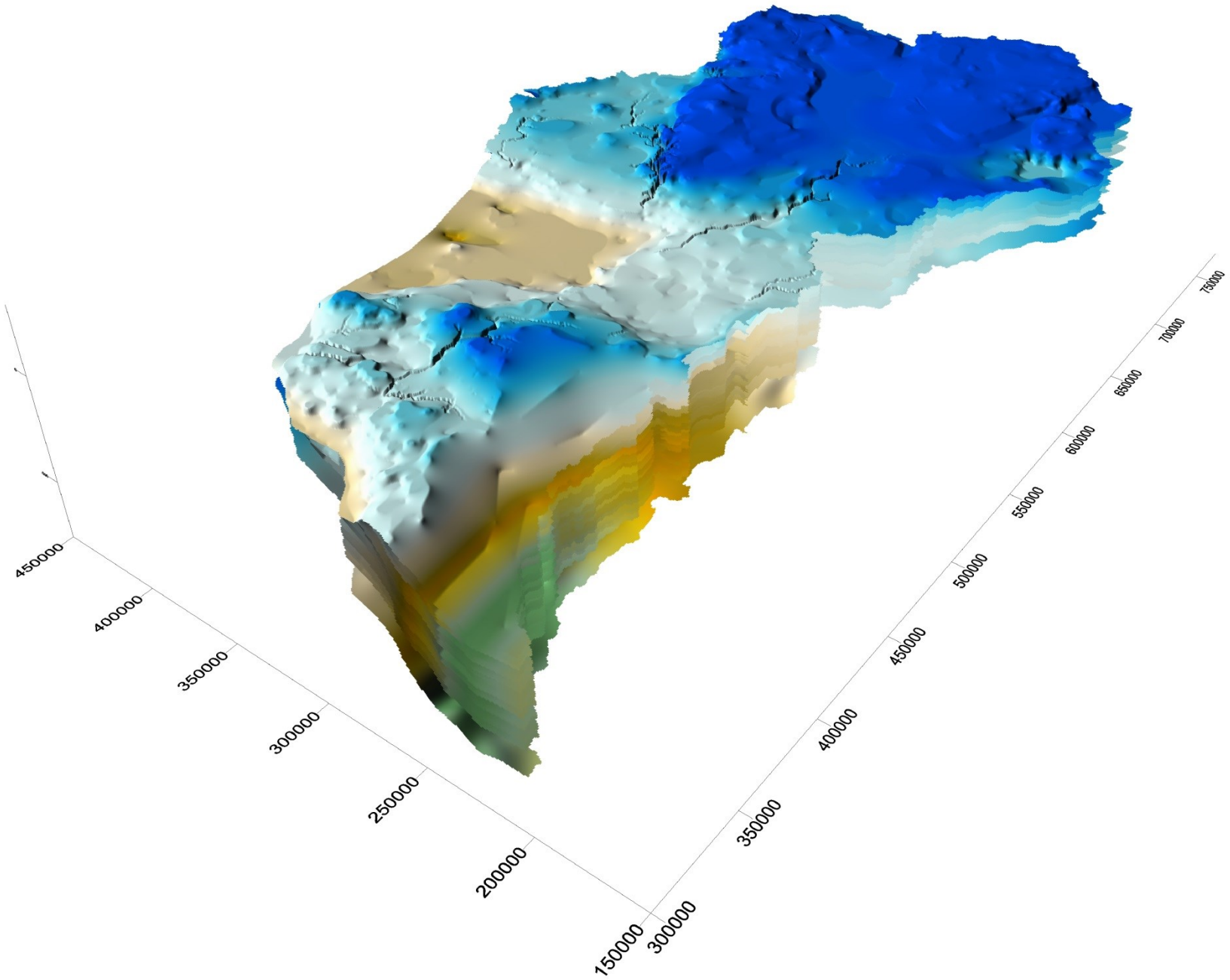
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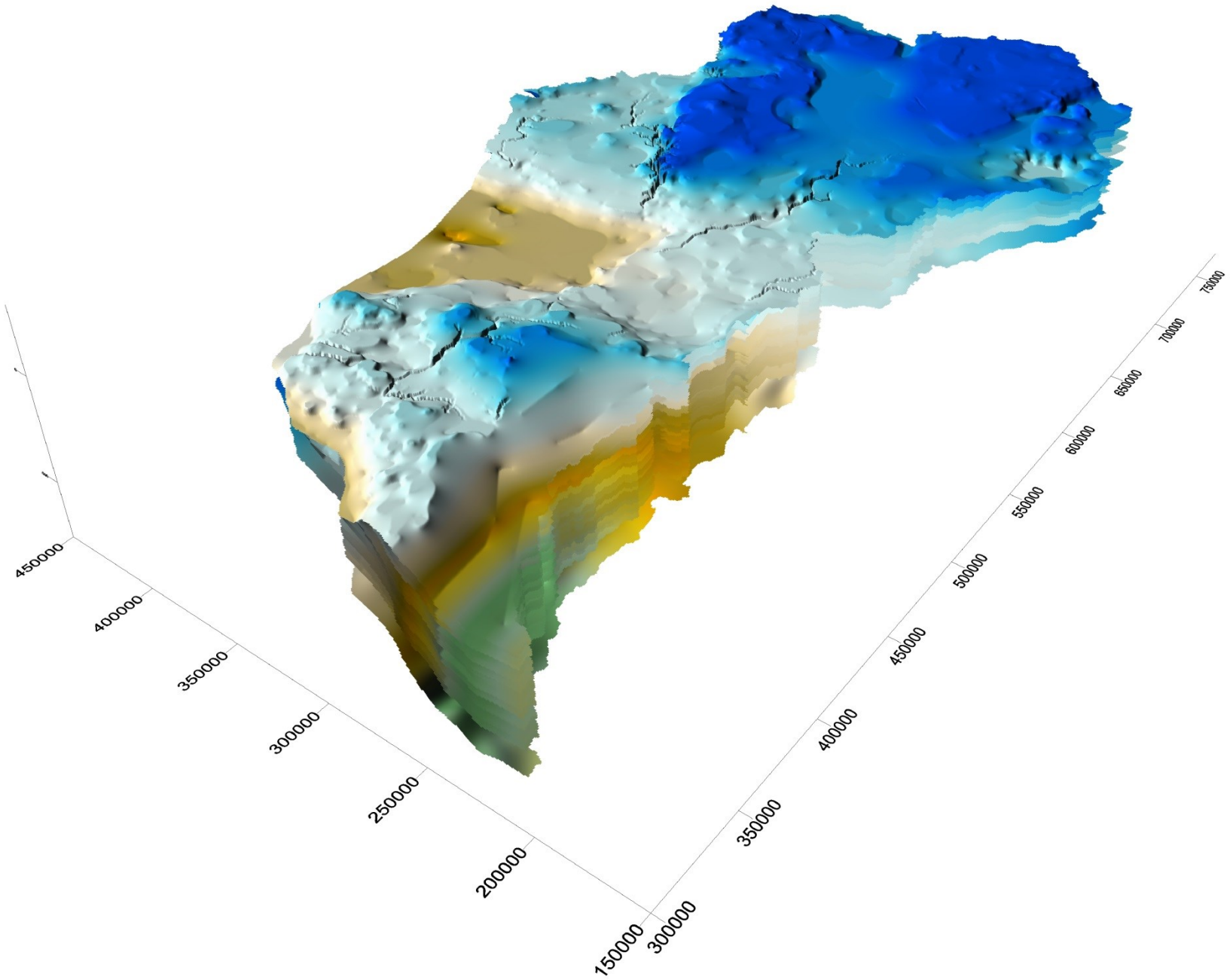
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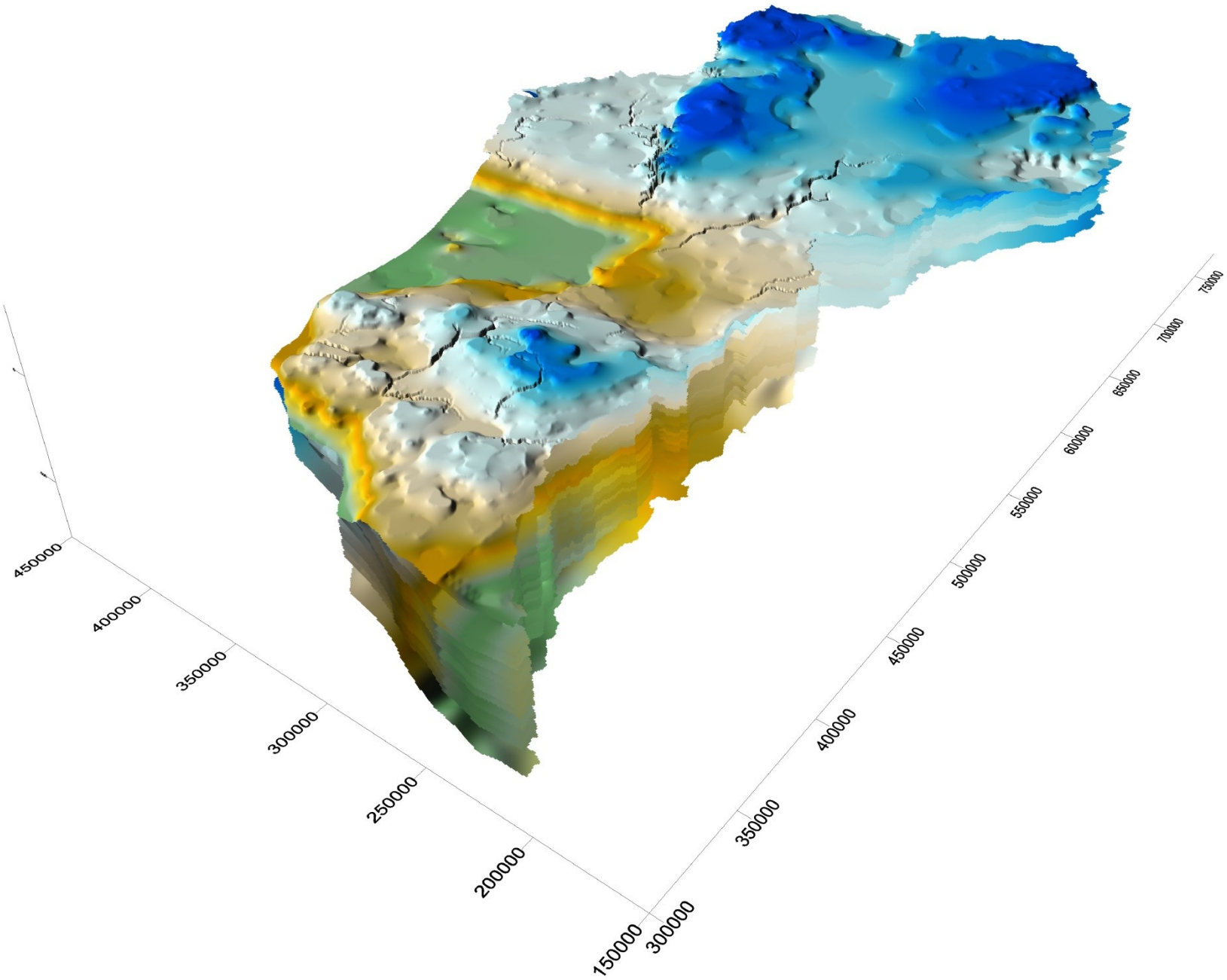
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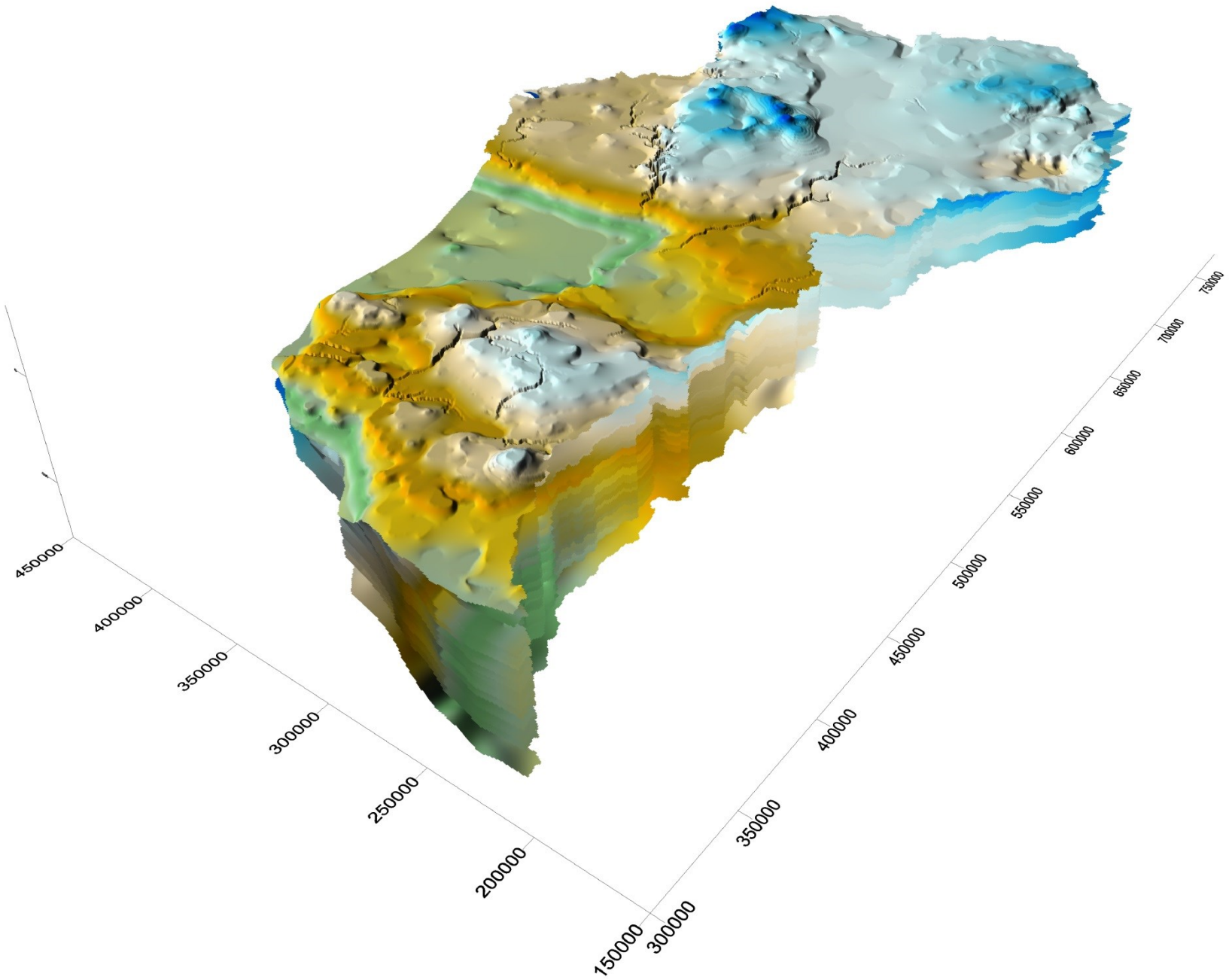
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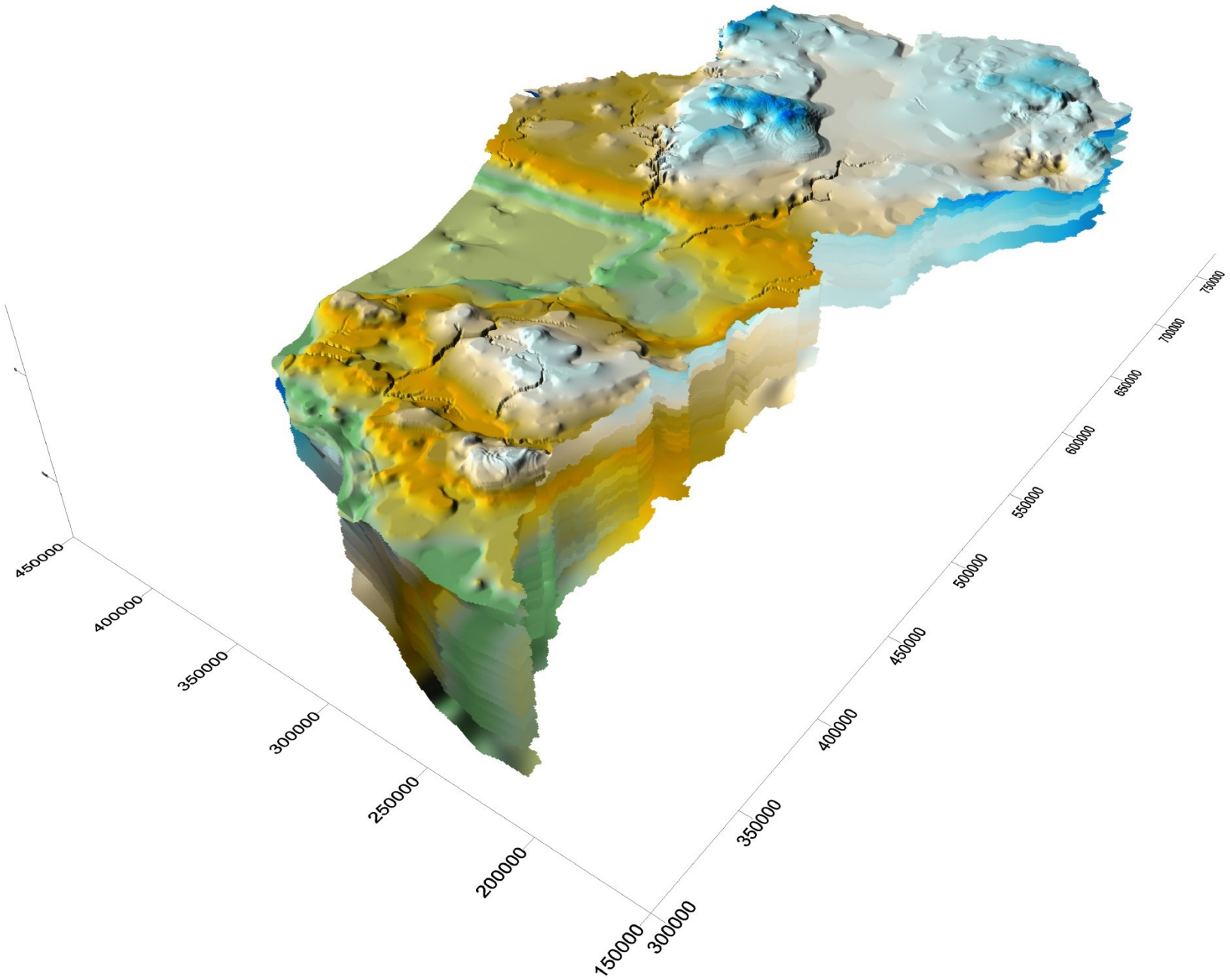
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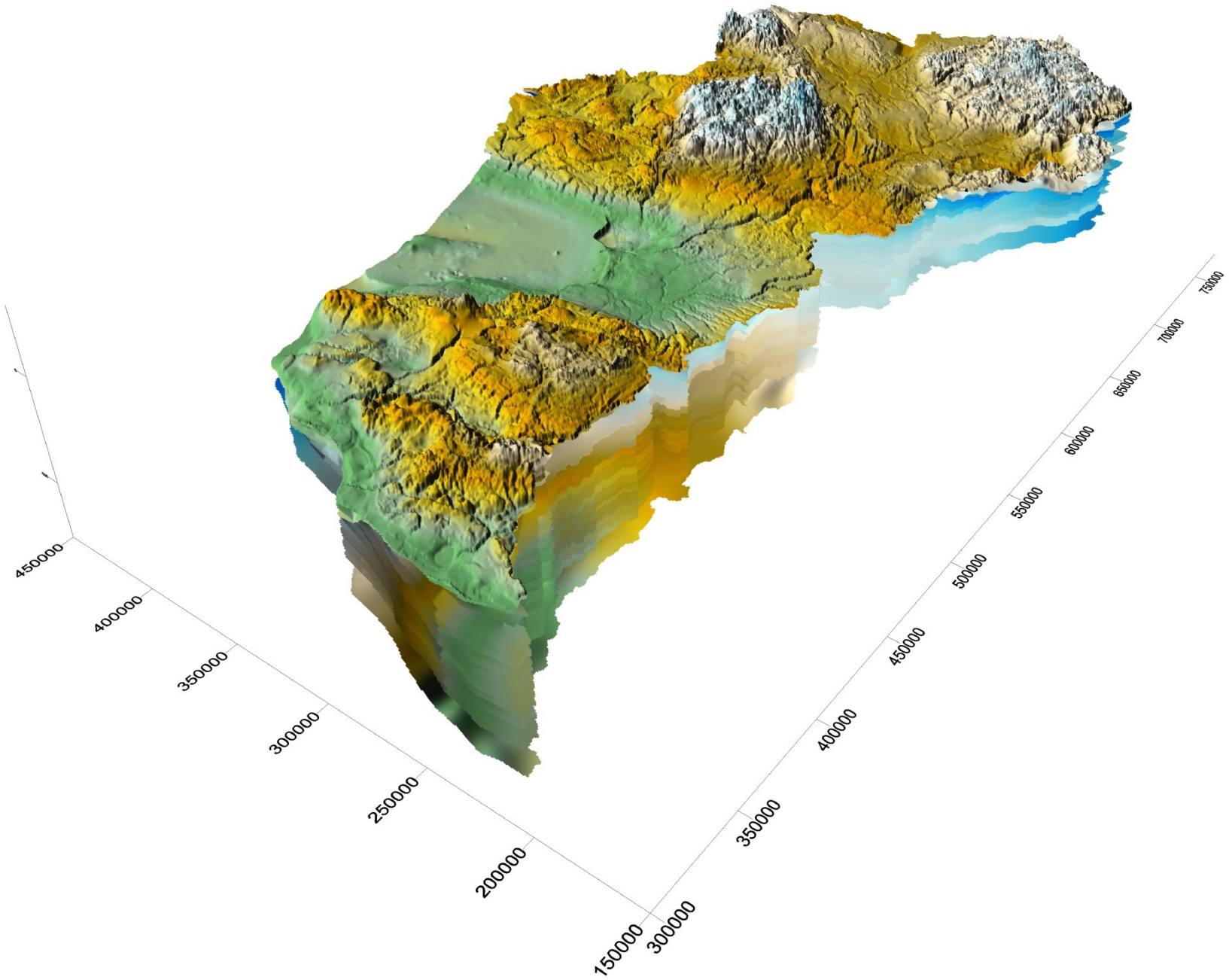
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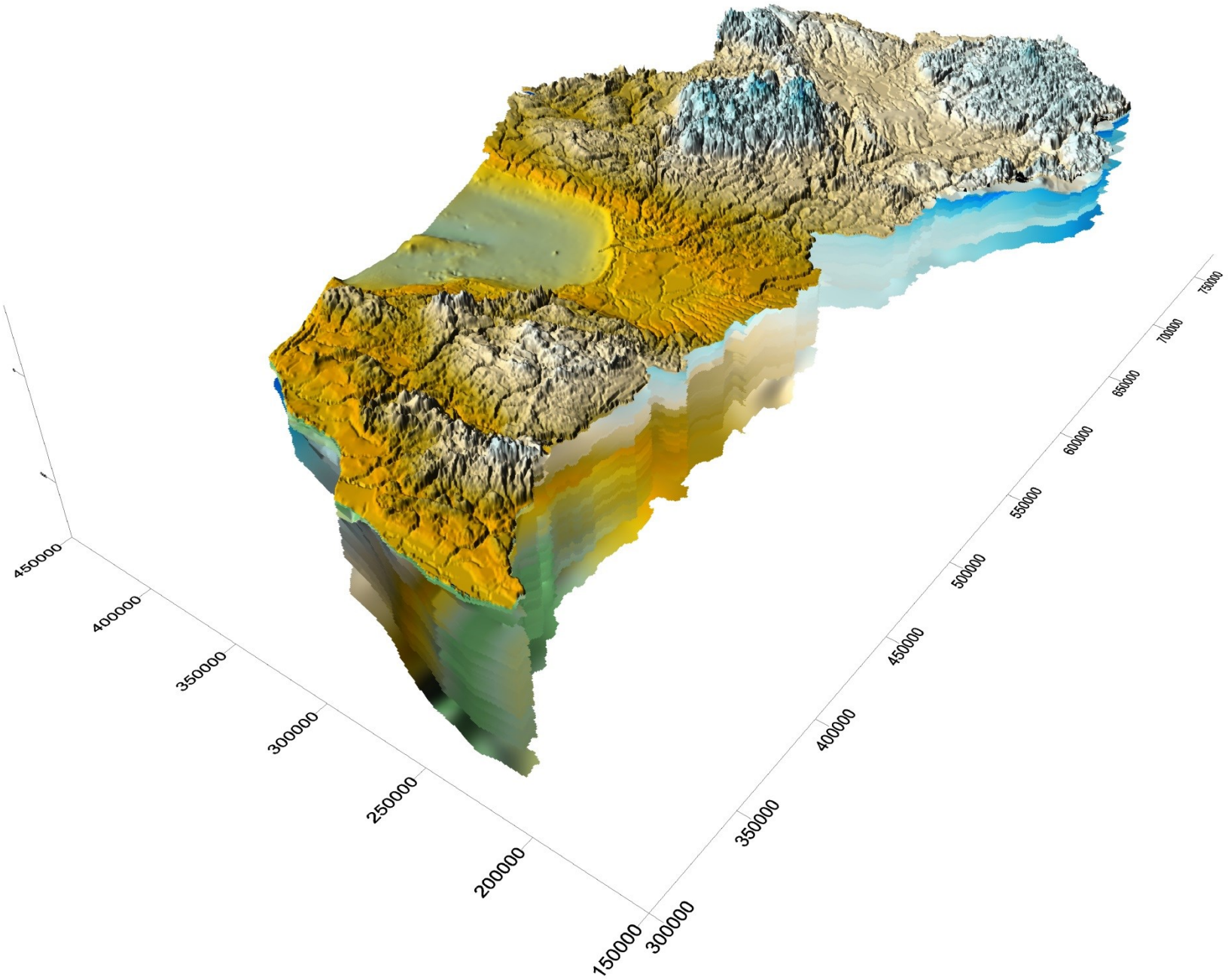
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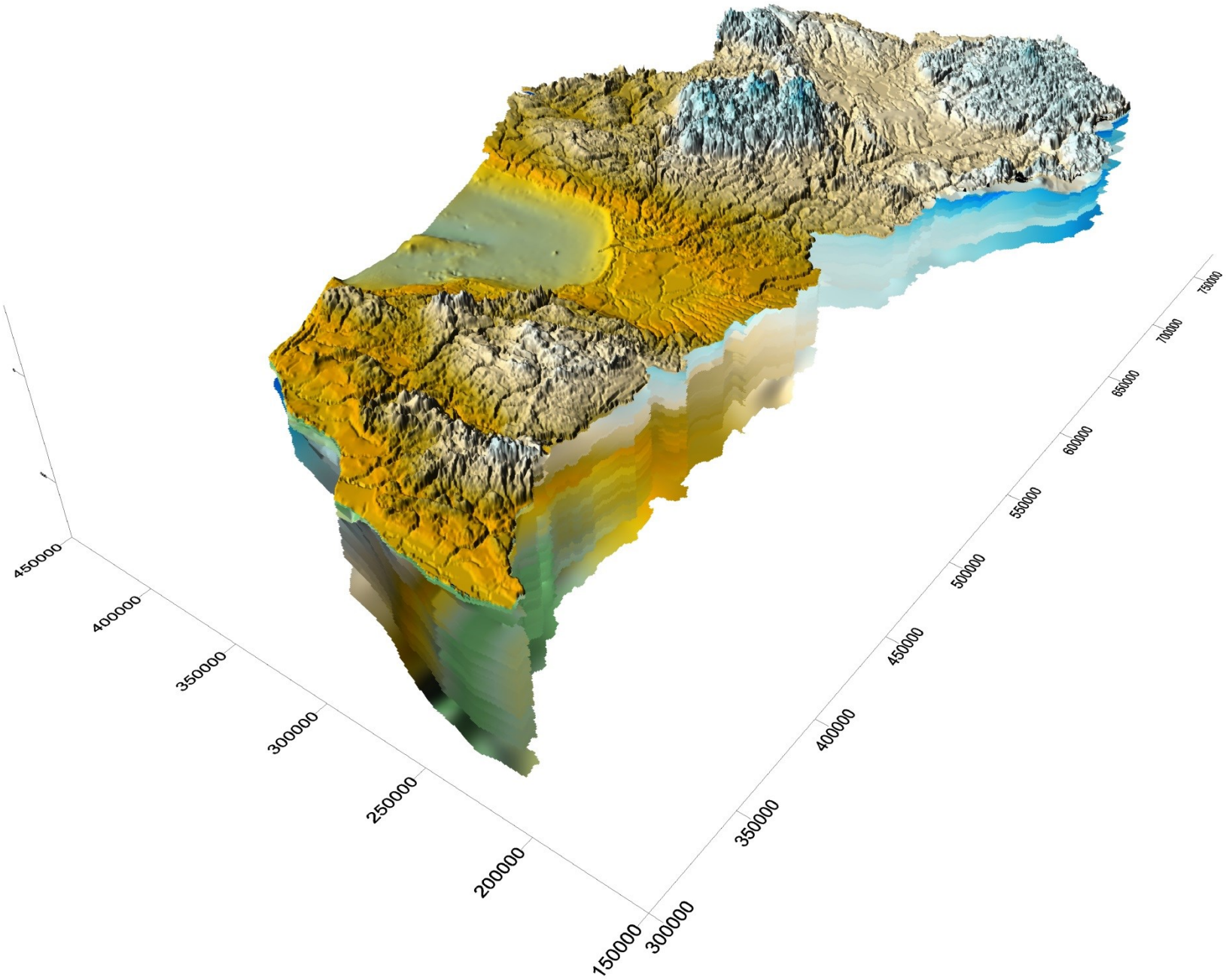
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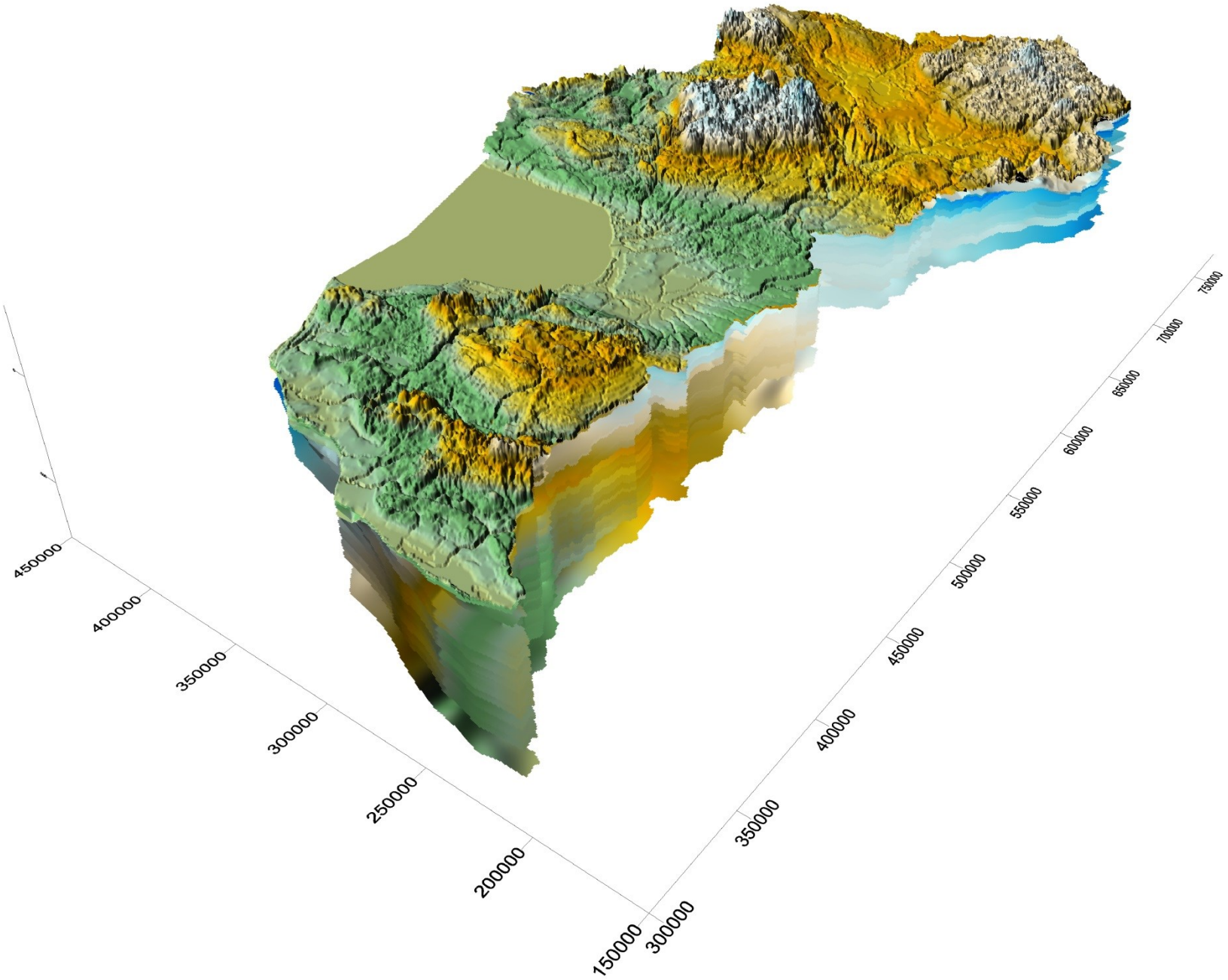
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Vector φ of the piezometric head is the numerical solution of the boundary field problem which is approximated in nodes of the HM *xyz*–grid by the following algebraic expression:

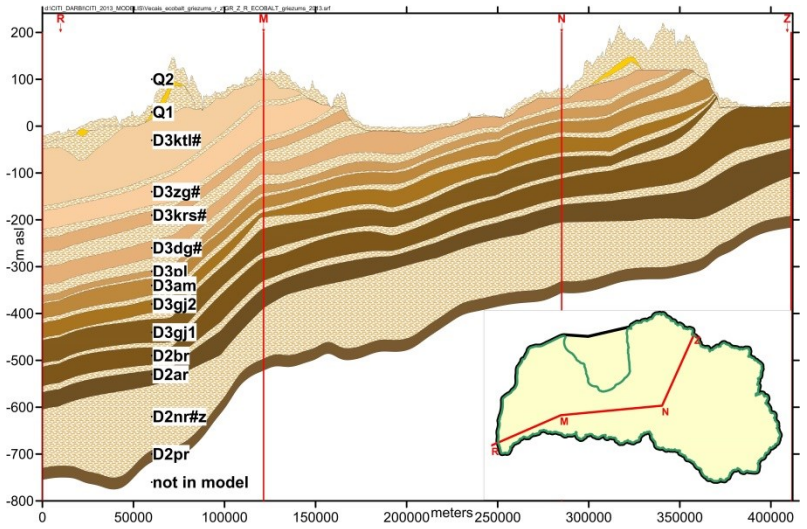
$$A\varphi=\beta-G\psi, \qquad A=A_{xy}+A_z \qquad (1)$$

where *A* is the symmetric sparse matrix of the geological environment which is presented by the *xy*-layer system containing horizontal and vertical hydraulic conductivity elements of the HM grid; G – the diagonal matrix (part of A)

Hydraulic conductivity

The elements a_{xy}, a_z of A_{xy}, A_z are computed as follows:

$$a_{xy} = k\,m, \quad a_z = (h^2\,k)/m,\ m_i = z_{i-1} - z_i\ , \quad i = 1, 2, \ \ldots, p \qquad (2)$$



Process of refining k-maps

- Refinement for aquitards:
  - Multiplying permeability maps 10-100 times
- Creating transmissivity maps for aquifers:
  - By using smart selection of well data from field tests
  - By correction of k, where m=0

Obtaining transmissivity data

$$S = \frac{Q}{2\pi T}(\ln(R/r) + \xi + \gamma) \qquad T = k\,m$$

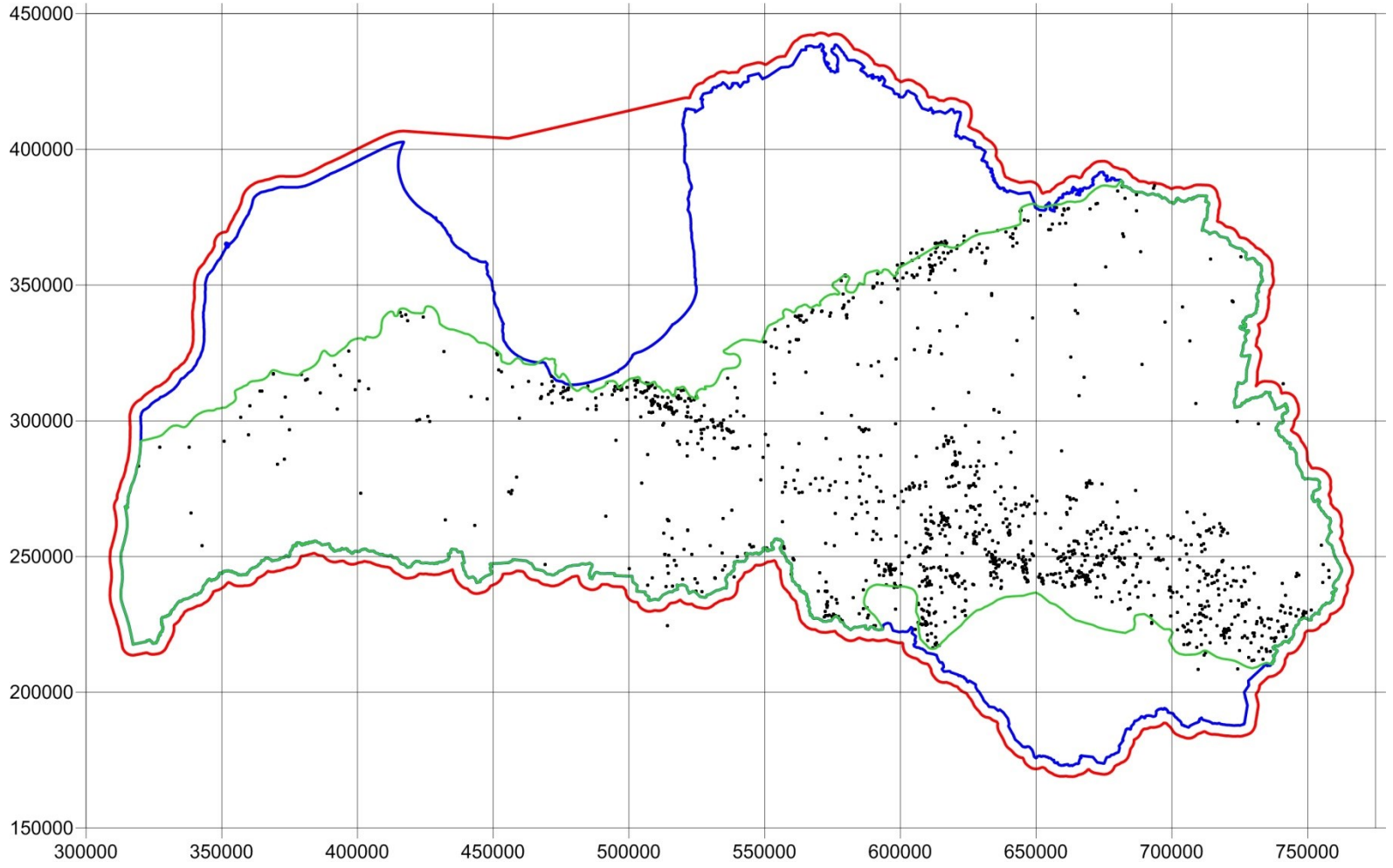
$$T = \frac{q}{2\pi}(\ln(R/r) + \xi) \qquad q = Q/S$$

$$T = 13.75q(\ln(R/r) + \xi)$$

$$T_{\min} = 137\,q$$

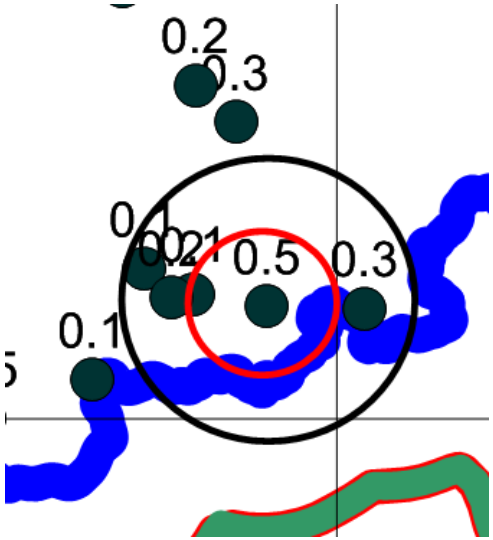
T-transmissivity, Q-discharge rate, S-drawdown, R- radius ofwell depression conus, r – radius of screen, k – permeability, m-thickness, ξ-hydraulic resistance, q-specific capacity of a well.

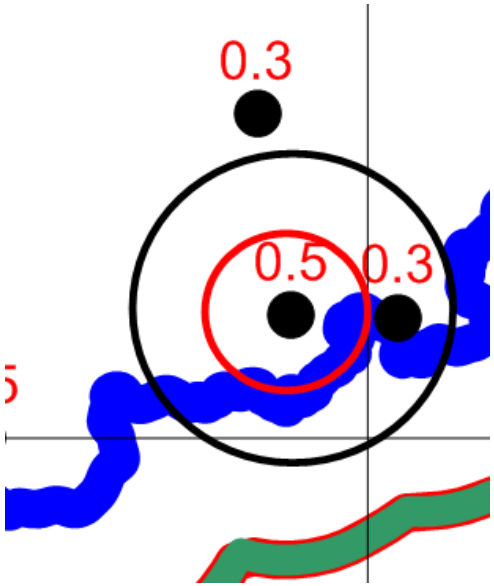
Locations of wells for the D3pl (15) aquifer



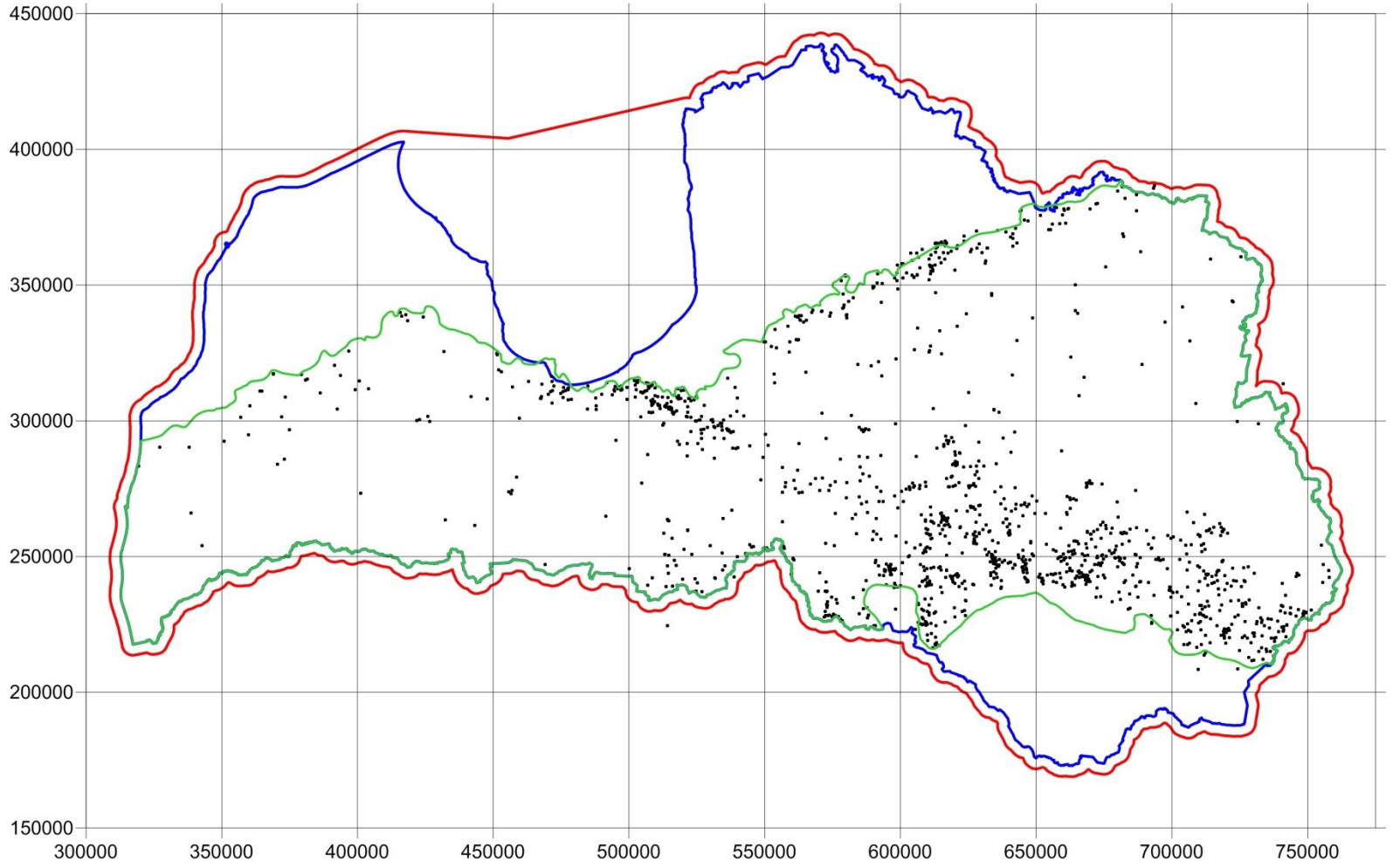
Selection of wells

1. Selecting stage.
2. Bounding stage.
3. Surviving stage.

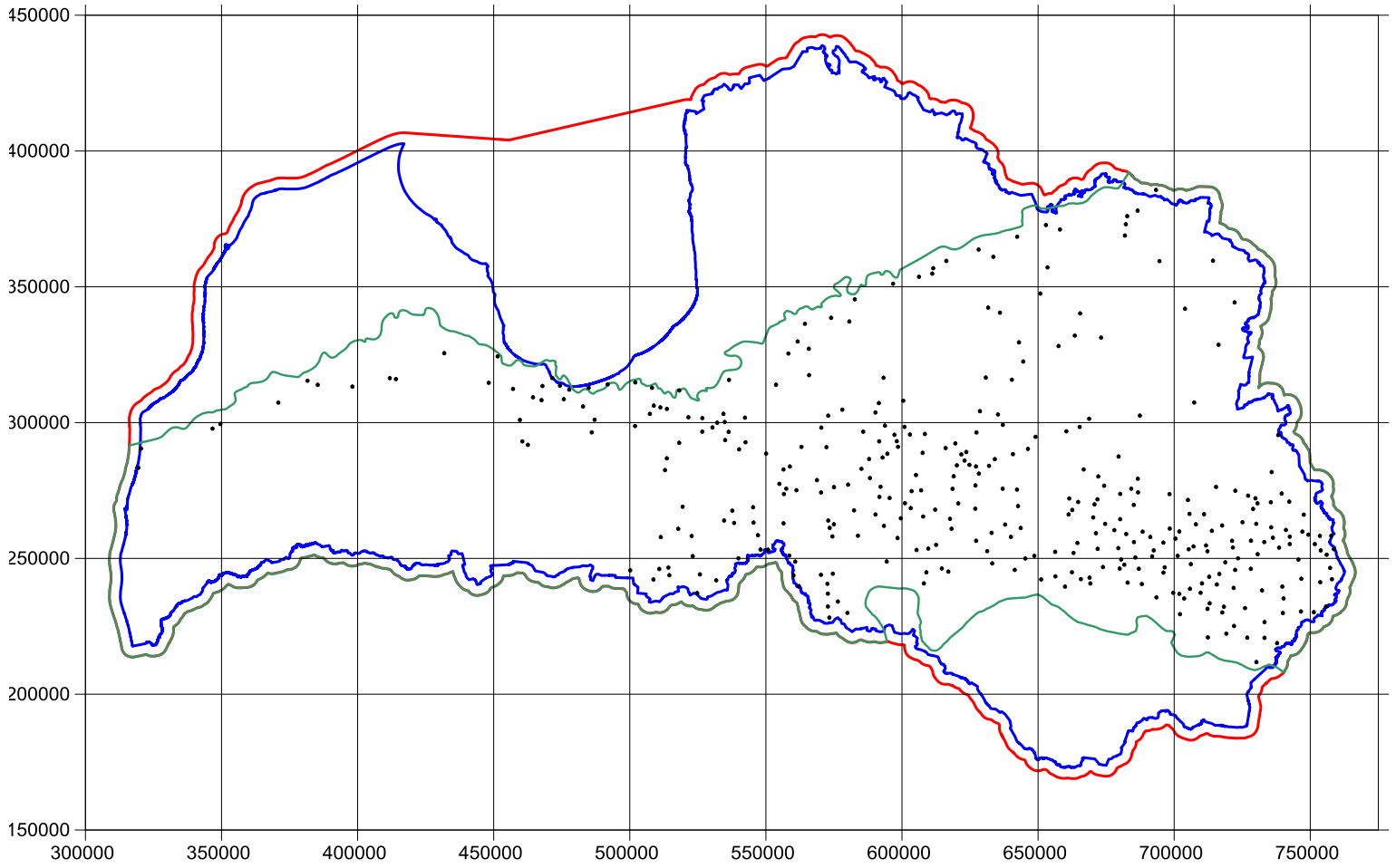




Locations of wells for the D3pl (15) aquifer



Selected wells for the D3pl aquifer



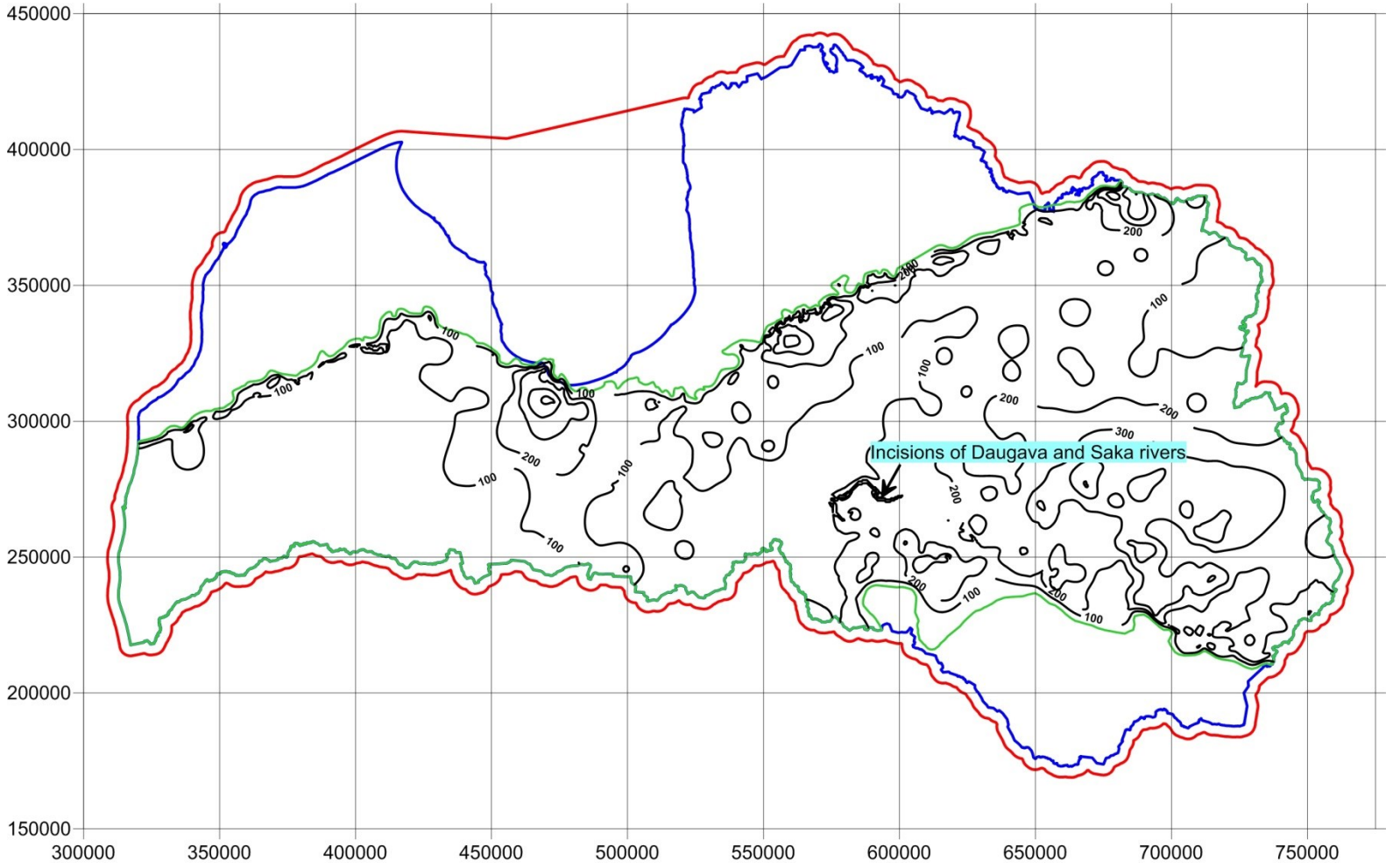
Reduction of initial data for k

Aquifer code	Number of wells				q_{mean}		
	deposited	selected	bounded	surviving	selected	bounded	surviving
D3ktl#	288	156	114	46	0.72	0.79	0.88
D3zg#	872	681	533	143	0.80	0.87	1.08
D3krs#	712	524	426	118	0.84	0.86	1.11
D3dg#	2284	959	819	256	1.17	1.15	1.74
D3pl	2874	1295	1073	374	1.08	1.05	1.46
D3am	778	526	420	190	0.64	0.71	0.80
D3gj2	5241	1229	1096	324	0.77	0.84	1.05
D3gj1	5346	1579	1378	425	0.82	0.88	1.18
D2brt	1867	1332	1020	367	0.71	0.80	0.99
D2ar	1740	1188	974	314	0.64	0.71	0.88

Obtaining of permeability maps

1. **Inverse distance to power** interpolation by Surfer.
2. Filtering using **low-pass filter** by Surfer.
3. Replacement of k values by k_{mean} values, where m=0.

The final T–map



Conclusions

1. LAMO model results improved
2. Some approaches for creating of permeability maps described

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