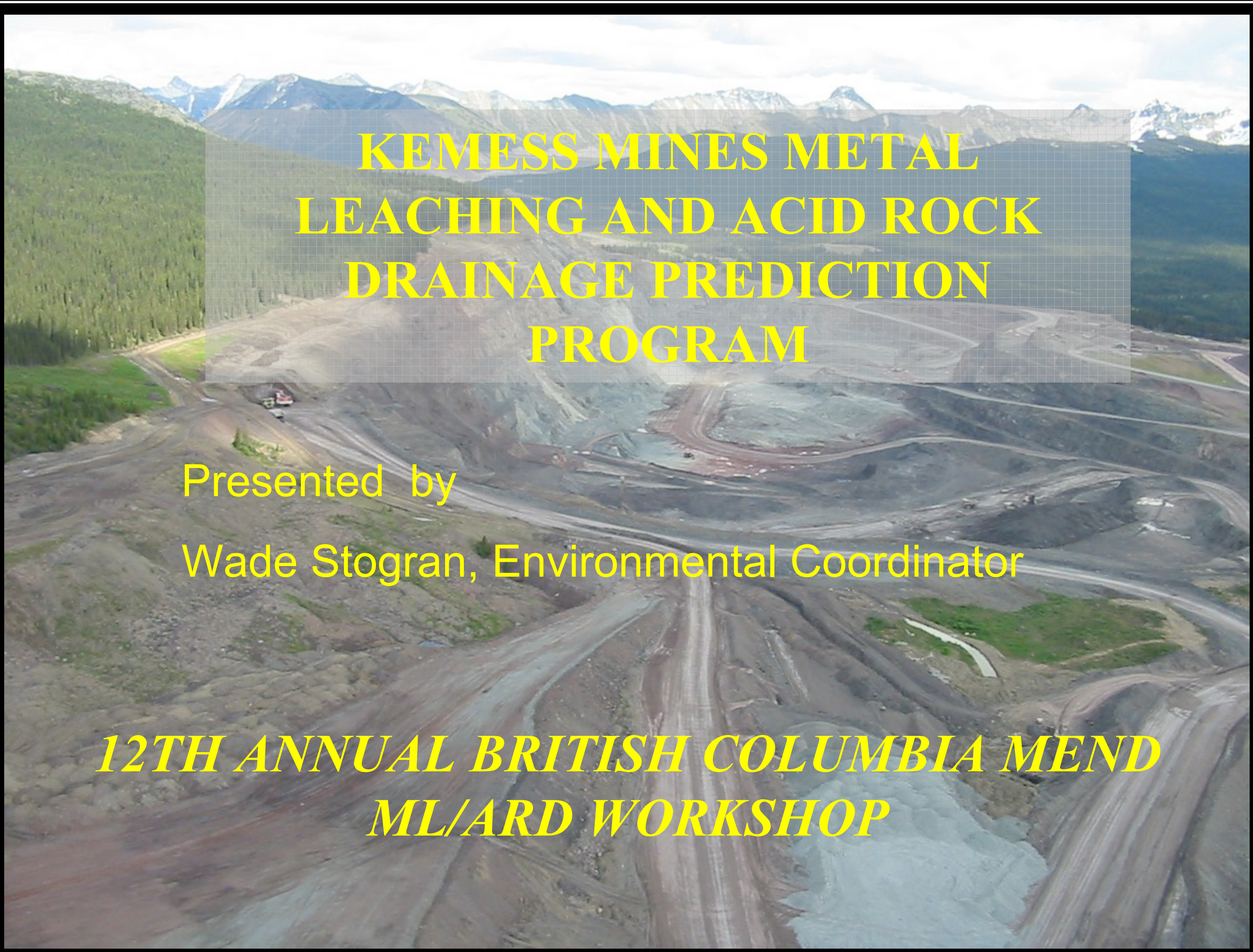


KEMESS MINES METAL LEACHING AND ACID ROCK DRAINAGE PREDICTION PROGRAM

Presented by

Wade Stogran, Environmental Coordinator

12TH ANNUAL BRITISH COLUMBIA MEND ML/ARD WORKSHOP

PRESENTATION GOALS

- To show the development of the Kemess South ML/ARD program and associated permitting from start-up to its current format.
- To show the evolution of the permit requirements resulting from close cooperation with regulatory agencies.




A BRIEF HISTORY LESSON

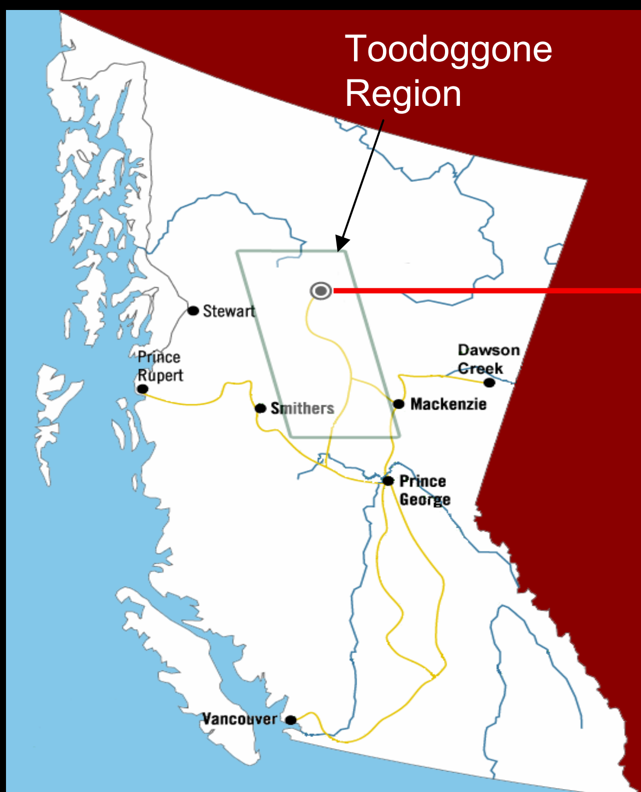
- The mine was in part a trade-off for the development of the Tatshenshini Provincial Park which included the proposed Windy Craggy Project owned by Geddes Resources.
- Geddes Resources stake in the operation was purchased by Royal Oak Mines.
- Construction started in 1996.
- Production of concentrate started in Fall 1998.
- The mine entered receivership during 1999.
- The mine was purchased by Northgate in February 2000.

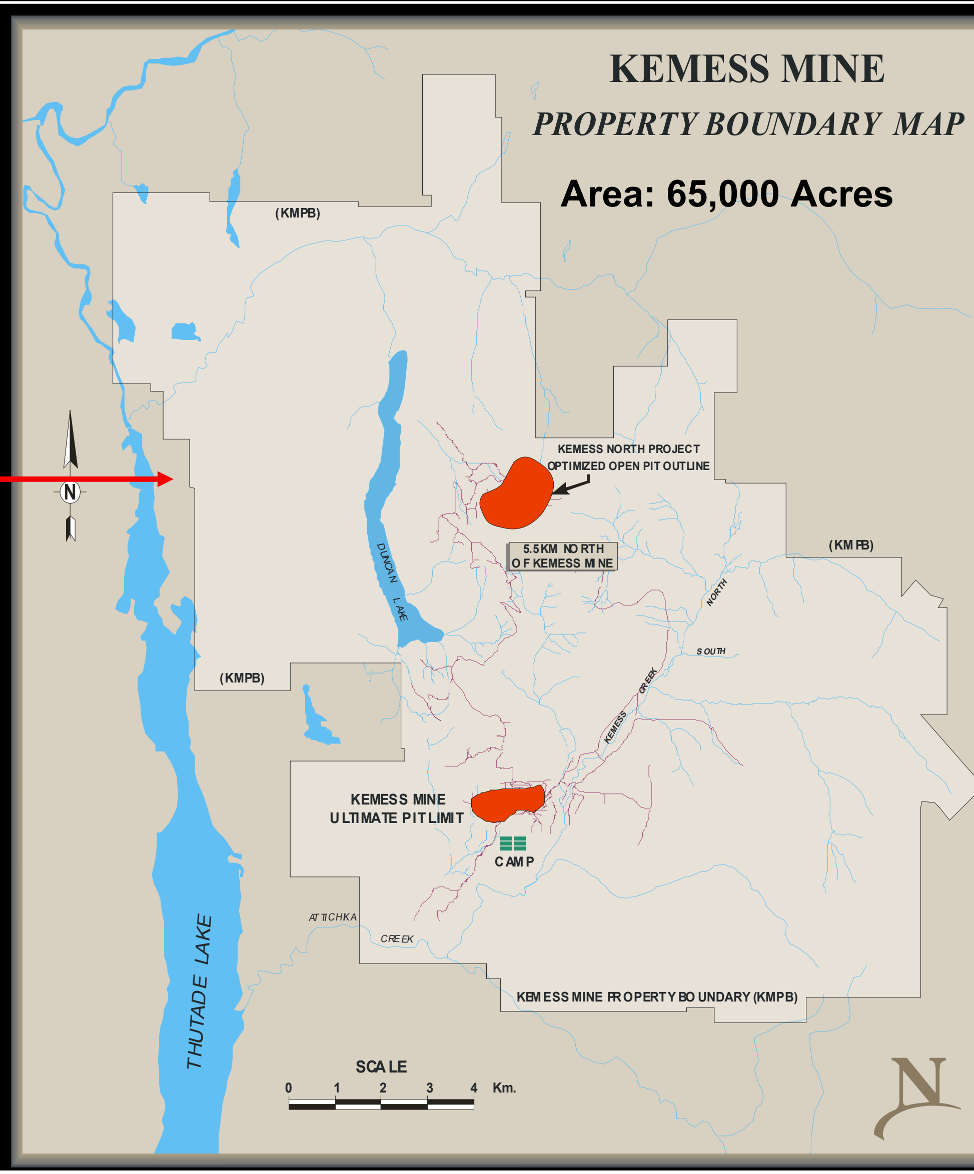
Kemess Mines Ltd.

Located in North-Central British Columbia

- **Mining rate**
  - 150,000 tonnes / day
- **Mill throughput**
  - 50,000 tonnes / day
- **Life of Mine (LoM) profile**
  - 275,000 oz/yr gold (in concentrate)
  - 74 million lbs/yr copper
  - Cash costs US$150/oz, net of credits
- **Reserves**
  - 91.7 million tonnes; >2 million oz of gold; 459 million lbs copper

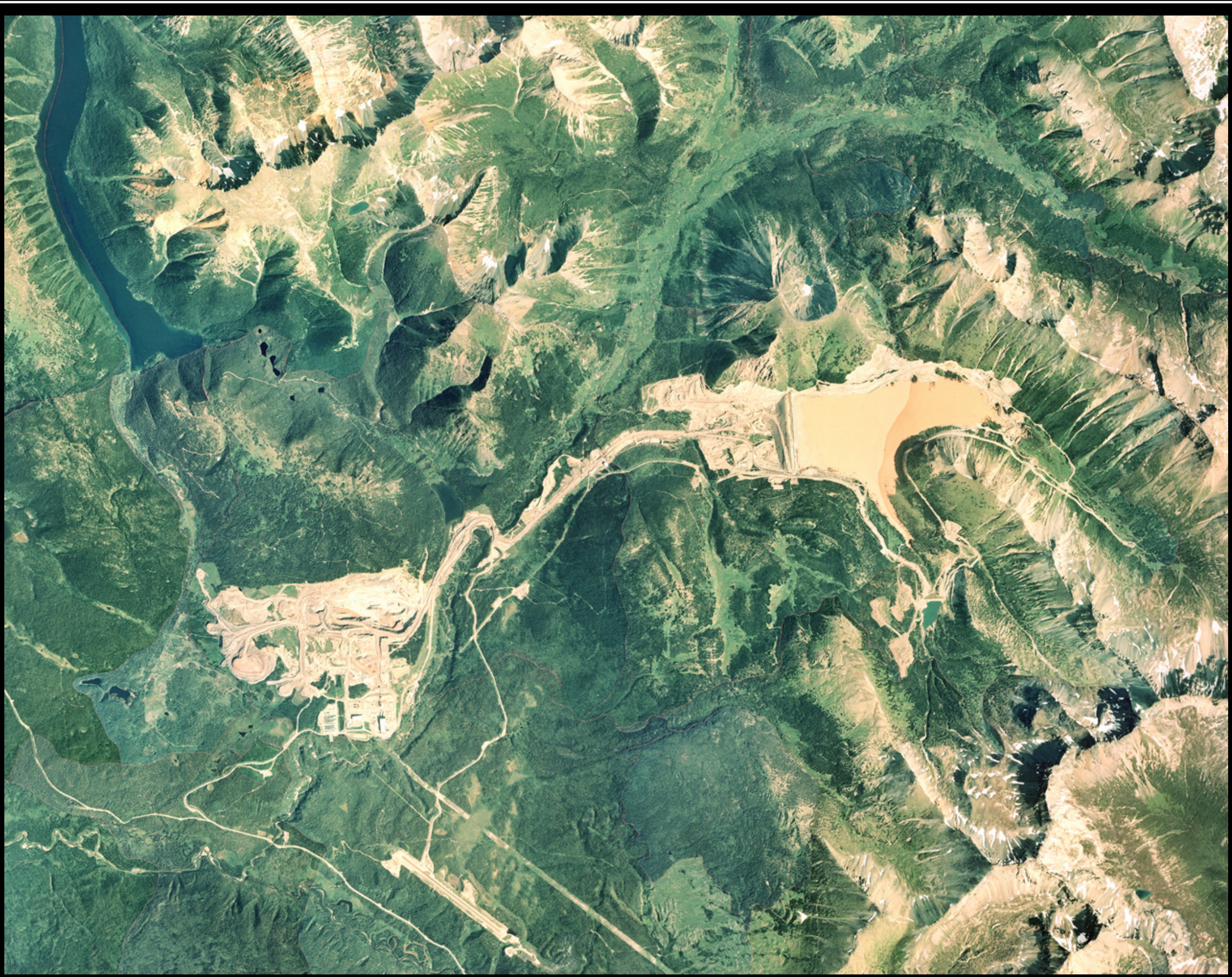




Toodoggone Region
Stewart
Prince Rupert
Dawson Creek
Smithers
Mackenzie
Prince George
Vancouver


KEMESS MINE
PROPERTY BOUNDARY MAP
Area: 65,000 Acres
(KMPB)
KEMESS NORTH PROJECT OPTIMIZED OPEN PIT OUTLINE
5.5KM NORTH OF KEMESS MINE
(KMPB)
DUNCAN LAKE
NORTH
SOUTH
KEMESS CREEK
(KMPB)
KEMESS MINE ULTIMATE PIT LIMIT
CAMP
ATTICHKA CREEK
THUTADE LAKE
KEMESS MINE PROPERTY BOUNDARY (KMPB)
SCALE
0 1 2 3 4 Km.
N




The Site

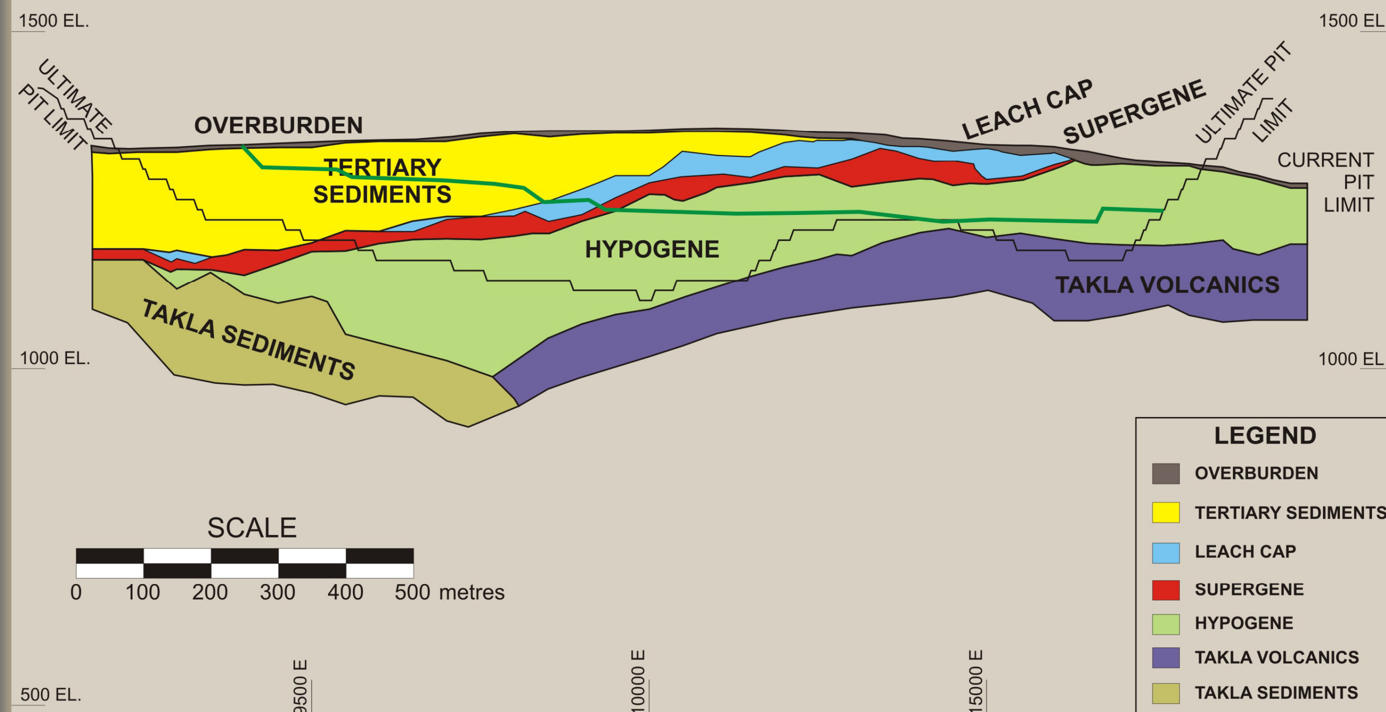


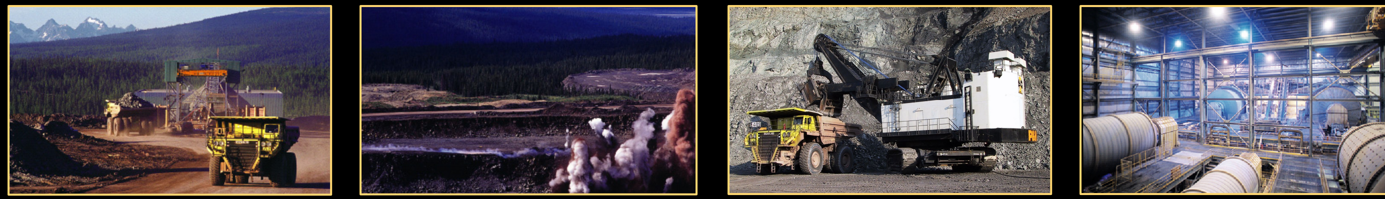
Northgate Exploration Limited

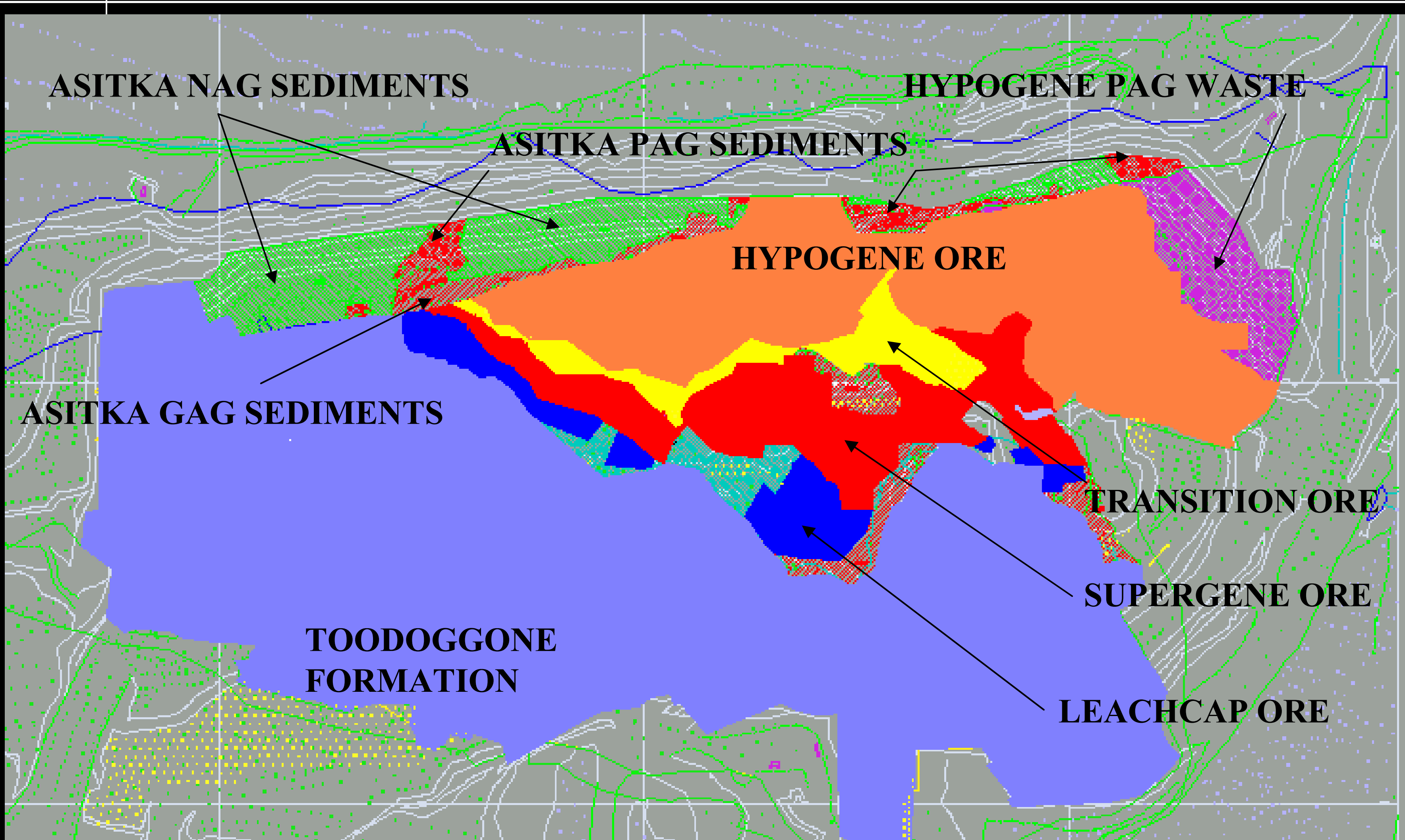
KEMESS MINE

LONGITUDINAL SECTION 9900N

GEOLOGY AND ULTIMATE PIT






ASITKA NAG SEDIMENTS
HYPOGENE PAG WASTE
ASITKA PAG SEDIMENTS
HYPOGENE ORE
ASITKA GAG SEDIMENTS
TRANSITION ORE
SUPERGENE ORE
TOODOGGONE
FORMATION
LEACHCAP ORE

Ore and Waste Rock Classifications

Material	Nature	Concerns	Waste Testing Methods
Overburden	Waste	None	ABA, ICP, XRD
Toodoggone Sediments	Waste	None	Shake Flask, Field Test
Asitka Group NAG and LAG	Waste	ML	ABA, ICP, Shake Flask, Field Test, Column Testing, XRD
Asitka Graphitics	Waste	ML/ARD	ABA, ICP, Shake Flask, Field Test, Column Testing, XRD
Asitka Group PAG	Waste	ML/ARD	ABA, ICP, Shake Flask, Field Test, Column Testing, XRD
Hypogene PAG	Ore, Waste, Sand	ARD	Humidity Cell, ABA, ICP, Shake Flask, Field Test, XRD
Leach Cap	Ore, Waste	ML	ABA, ICP, Shake Flask, Field Test, Column Testing, XRD
Supergene	Ore, Waste	Low PAG	Humidity Cell, ABA, ICP, XRD
Takla Volcanic Sediments	Ore, Waste	ML/ARD	ABA, ICP, Shake Flask, Field Test, Column Testing, XRD




Overburden and Non-lithified Sediments

- Consists of a wide variety of material types on the site but predominantly ablation and basal till in the area of the open pit,
- 8 samples analyzed during initial testwork indicated an absence of sulphides and all samples as slightly acid consuming,
- Initial permit sampling requirement of 1 pre-blast sample per 100,000 tonnes mined,
- Overburden stripping for the open pit was completed during 2003 with the exception of minor amounts excavated during work on the northwest corner of the open pit.
- Testwork shows these materials to be overall slightly acid neutralizing based on minor carbonate mineralization.




Toodoggone Sediments

- Toodoggone is a mixture of non-mineralized sedimentary and volcanic rocks with a calcite-bearing matrix,
- ABA testing conducted on 27 samples as part of initial static testing program with an additional 60 samples analyzed during the detailed static test program,
- Petrographic analysis conducted on 10 samples
- Results indicated low sulphur content, low acid generation potential and high acid consumption.
- Initial permit sampling requirement of 1 pre-blast sample per 100,000 tonnes mined,
- In November 2001 the requirement to sample the Toodoggone units was removed based on a review of ABA, ICP and petrographic results except where the Toodoggone cannot be segregated from the adjacent Asitka and Leach Cap units.




Asitka Sedimentary Group (NAG, PAG, and Graphitics)

- Sedimentary rocks interlayered with volcanic rocks. Sedimentary rocks found to have generally high corbonate content and be net acid consuming while volcanics found to host significant pyrite mineralization and tended to be net acid producing. LAG material is visibly similar to Leach Cap and handled in the same manner,
- Initial criteria of NPR<3 or sulphide-S > 0.8% used to delineate PAG,
- Little detailed information this waste rock existed from pre-development. Large testwork program initiated during 2000 and 2001 to further characterize this material,
- Graphitic sediments found to be potentially acid generating and metals leaching,
- Initial preblast and post blast sampling every 20,000 tonnes,
- During late 2001 temporary storage of Asitka Graphitics and Asitka PAG on an above ground stockpile was permitted,
- During 2002 the post blast frequency was increased to every 30,000 tonnes in area of PAG.




Hypogene

- Mineralized quartz monzodiorite representing the bulk of the ore within the Kemess South deposit. Approximately 3 million tonnes moved as waste will be milled at end of mine life.
- A total of 57 samples from 24 diamond drill holes showed material to be slightly acid generating. A further 175 ABA samples analyzed with only 60% of samples found to be potentially acid generating,
- Initial pre and post blast sampling conducted every 20,000 tonnes,
- During late 2001 temporary storage of Hypogene waste on an above ground stockpile was permitted,
- During 2002 permit amendment reduced post blast sampling frequency to 1 sample every 100,000 tonnes.




Leach Cap

- Oxidized intrusive rock overlying the supergene ore. The copper originally within this unit has leached into the underlying supergene materials but there is gold within this unit,
- Originally classification identified both NAG (NPR>2) and PAG (NPR<2),
- Leach Cap zone found to contain low level of total-S (0.01-0.12%), acid leachable-S (0.00-0.08%) and NP (50% < 10kg/t),
- Petrographic analysis of 17 samples indicated the presence of barite, BaS04, which is non-acid leachable. Approximately 40% of total-S found to occur as barite,
- All samples of Leach Cap found to be NAG when barite is factored into AGP,
- All Leach Cap handled as NAG since early 2000,
- High metals leaching concern (Se) associated with Leach Cap.




Supergene

- A 10 m to 70 m band of altered quartz monzodiorite overlying the hypogene. Sulphides found to be esentially absent in material indicating full oxidation has already occurred. Copper mineralization includes presence of native copper,
- No potential for metals leaching found based on humidity cell testwork,
- Pre blast sampling conducted every 20,000 tonnes,
- Initial plan called for milling all supergene ore however the possibility of supergene waste being moved does exist.




Takla Volcanics

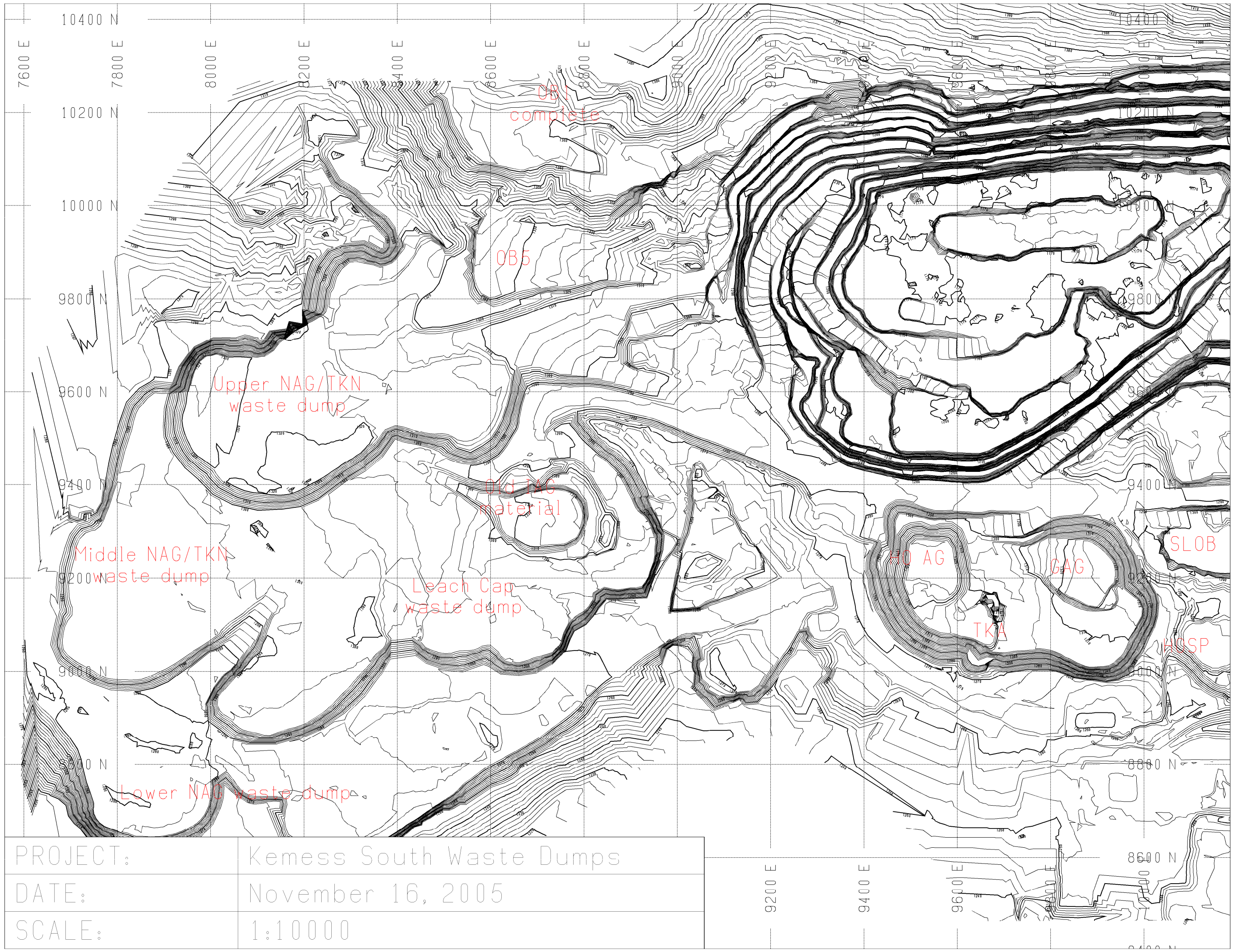
- This rock underlies the quartz monzodiorite intrusive. Contains penetrative chloritic alteration and has some economic mineralization,
- Rock found to have generally high sulphide-S (2-12%) and moderately low carbonate content (1-7%). Rock determined to be net acid generating,
- Pre blast and post blast sampling for this unit proposed to be conducted at same frequency as Asitka PAG materials,
- A total of 1.8 million tones of this material to be moved as waste based on current mine plan.




Waste Rock Disposition

- Prior to November 2005 all non-acid generating (NAG) waste rock was disposed of in the non-acid generating Waste Rock Dump. All Potentially Acid Generating (PAG) material excavated prior to November 2001 was hauled to the Tailings Storage Facility for sub-aqueous disposal,
- In November 2001 all PAG rock was permitted for disposal in a temporary stockpile located to the south of the open pit. All PAG rock in this stockpile must be disposed in a flooded location,
- In November 2005 permitting was obtained to allow for the disposal of all PAG and NAG waste rock into the eastern portion of the open pit to a maximum elevation of 1255 m. This has greatly reduced the waste haul distance.

Waste Dumps


OB1
complete
OB5
Upper NAG/TKN
waste dump
Old IAG
material
Middle NAG/TKN
waste dump
Leach Cap
waste dump
Lower NAG waste dump
HO AG
GAG
TKA
SLOB
HOSP
PROJECT: Kemess South Waste Dumps
DATE: November 16, 2005
SCALE: 1:10000




Kemess Mines On-Site Static Testing

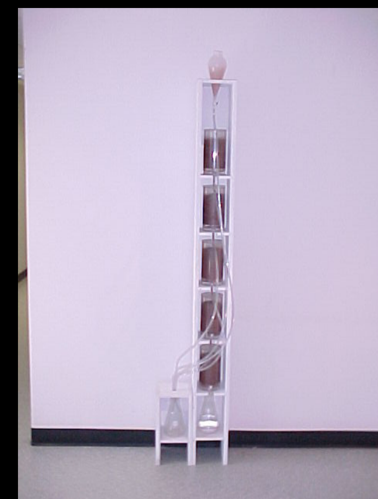
- Static Tests are conducted by the Kemess Mines Assay Lab.
- Static testing conducted at the site includes ABA and Shake Flask Tests.




KEMESS

Kemess Mines On-Site Kinetic Testing

- Kinetic test work is conducted at the site in the Environmental Laboratory.
- Kinetic tests conducted in the lab include Humidity Cell Tests, Field Weathering Pads and column testing.






Field Leach Cell Testing

Pad Number	Material	Date Installed
LTP 1	Hypogene Waste Rock	1999
LTP 2	Leach Cap Rock	1999
LTP 3	Asitka Chert Rock	1999
LTP 4	Asitka Graphitic Rock	1999
LTP 5	Leach Cap Rock	2000
LTP 6	Leach Cap Rock	2000
LTP 7	Hypogene PAG Waste Rock	2002
LTP 8	Hypogene PAG Waste Rock	2002
LTP 9	Hypogene PAG Waste Rock	2002
LTP 10	Asitka Chert Talus	2003
LTP 11	Asitka Chert Talus	2003
LTP 12	Asitka Chert Talus with 10% Asitka Graphite	2003
LTP 13	Hypogene Cyclone Sands	2004
LTP 14	Toodoggone Sediments	2004
LTP 15	Takla Volcanic Rock	2005
LTP 16	Takla Volcanic Rock	2005




Field Leach Cell Testing

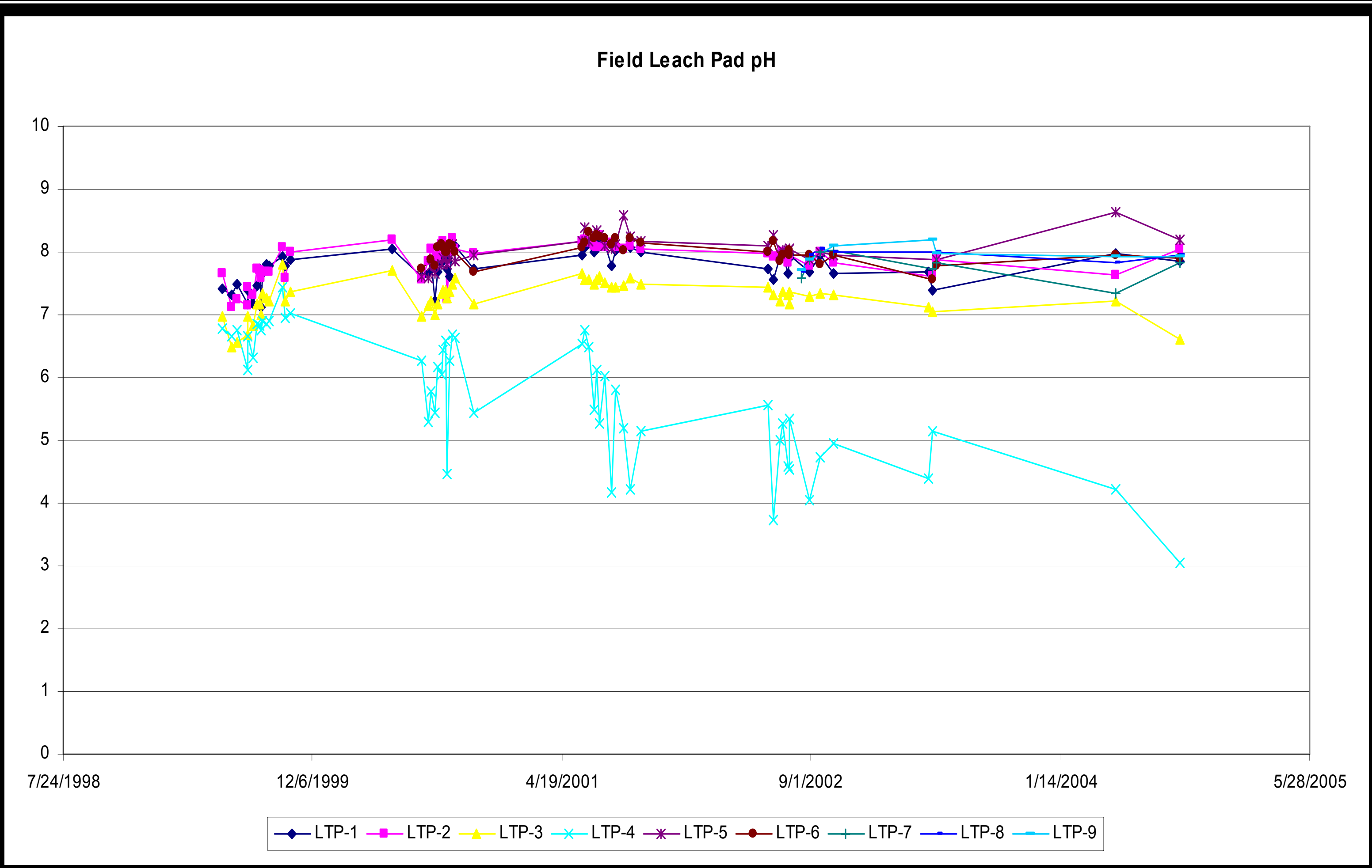
Initial Results

Pad	Material	Total -S	MPA	% C	NP
LTP 1	Hypogene Waste Rock	2.45	76.25	---	24.90
LTP 2	Leach Cap Rock	0.05	1.25	---	5.50
LTP 3	Asitka Chert Rock	2.41	75.31	0.22	18.30
LTP 4	Asitka Graphitic Rock	2.06	64.36	0.10	8.30
LTP 5	Leach Cap Rock	0.01	1.00	---	22.74
LTP 6	Leach Cap Rock	0.10	2.00	---	6.00
LTP 7	Hypogene PAG Waste Rock	2.55	79.69	0.52	55.83
LTP 8	Hypogene PAG Waste Rock	1.50	46.88	0.29	52.02
LTP 9	Hypogene PAG Waste Rock	1.85	57.81	0.34	53.03
LTP 10	Asitka Chert Talus	0.82	25.59	1.10	91.50
LTP 11	Asitka Chert Talus	2.21	69.06	0.14	11.30
LTP 12	Asitka Chert Talus with 10% Asitka Graphite	1.81	56.56	0.09	7.10
LTP 13	Hypogene Cyclone Sands	0.17	5.09	0.28	27.40
LTP 14	Toodoggone Sediments	0.12	3.28	0.55	43.30
LTP 15	Takla Volcanic Rock	1.59	49.69	0.46	52.00
LTP 16	Takla Volcanic Rock	3.74	116.88	0.59	62.40




Field Leach Cell

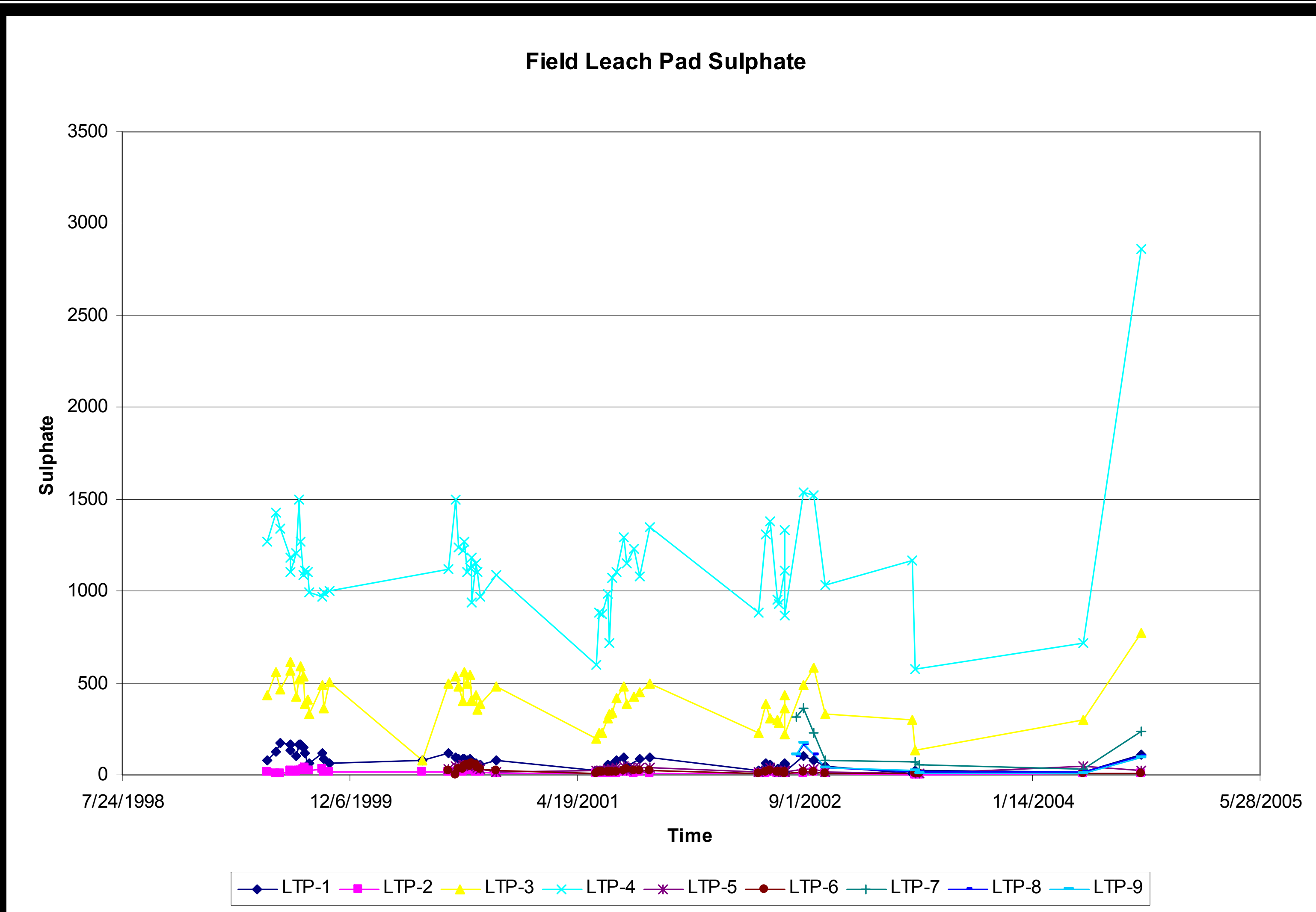
Leach pH Data






Field Leach Cell

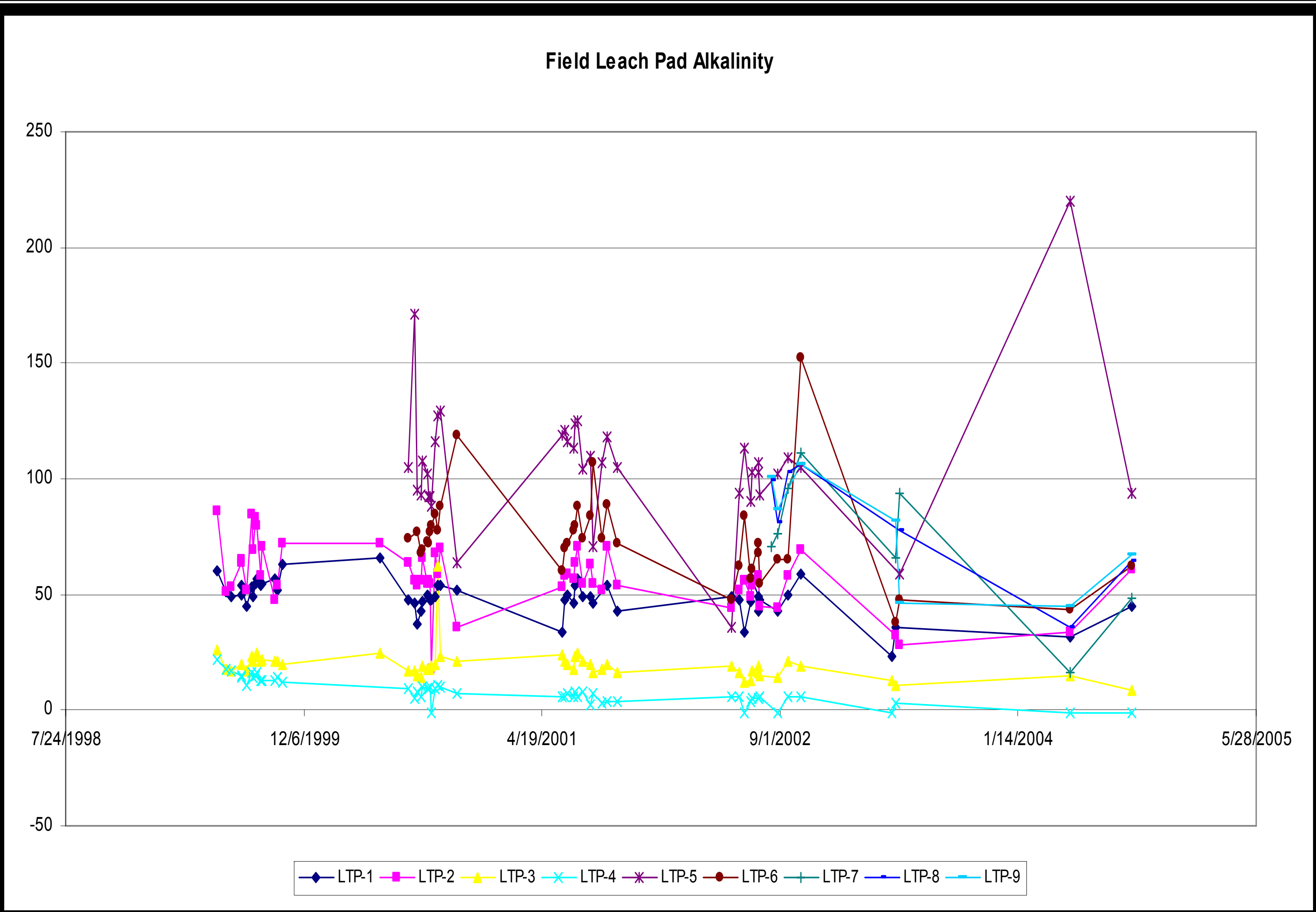
Leach Sulphate Data






Field Leach Cell

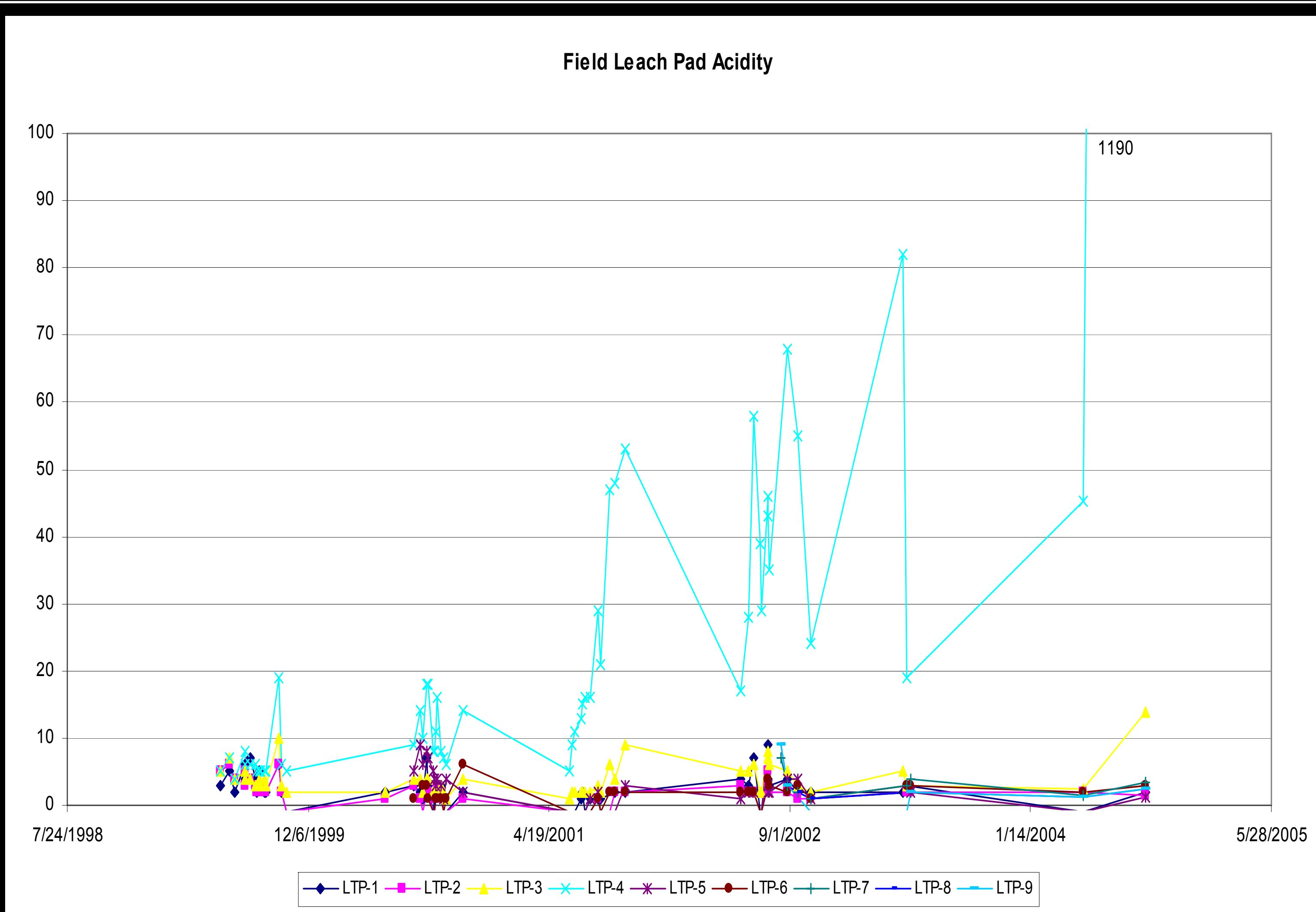
Leach Alkalinity Data

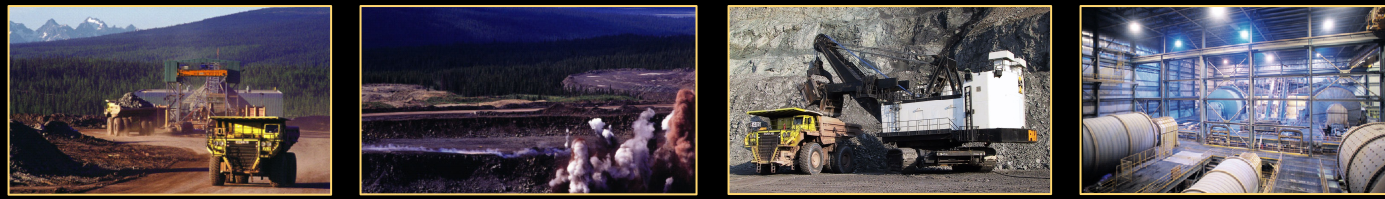




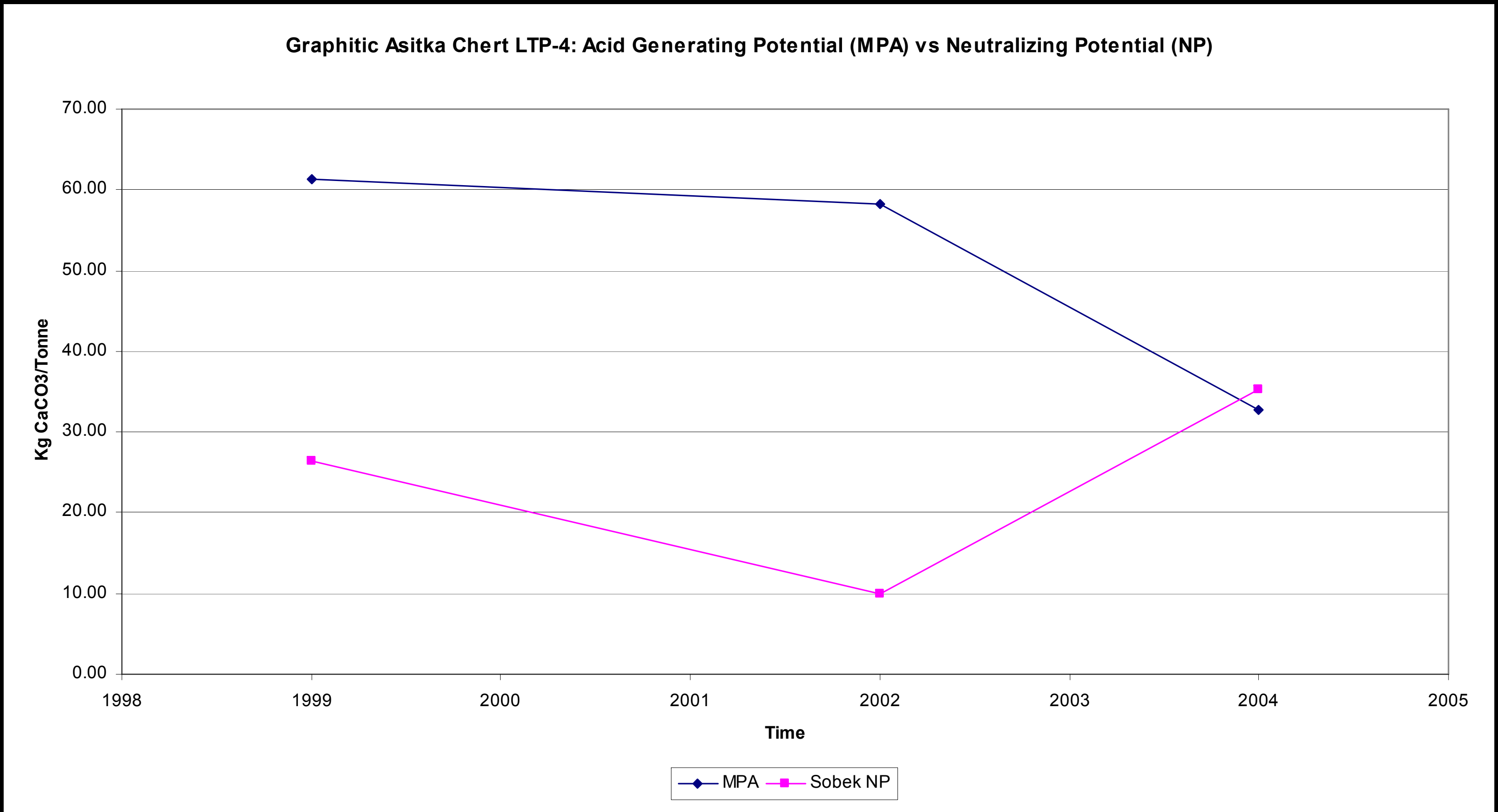

Field Leach Cell

Leach Acidity Data

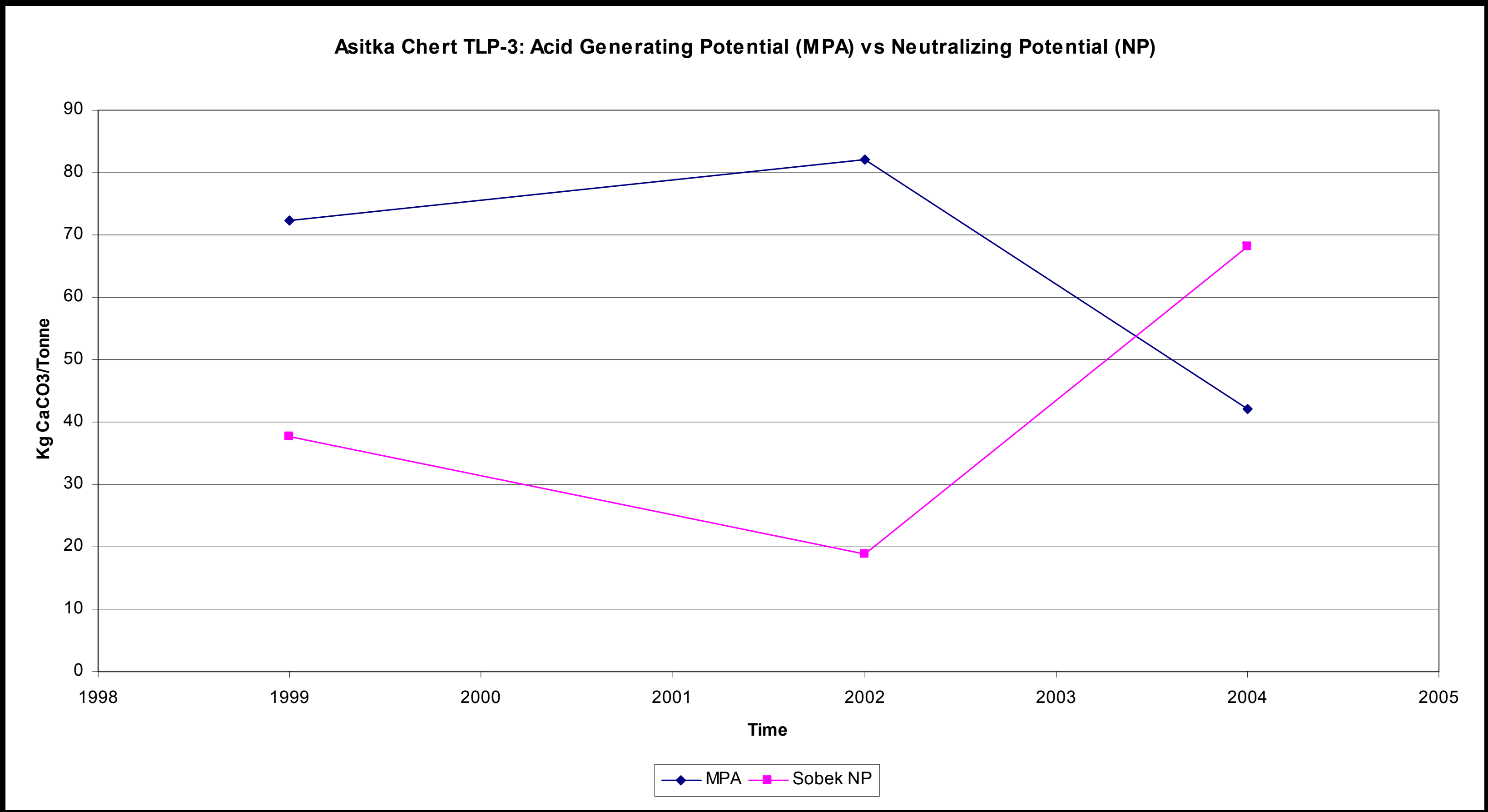


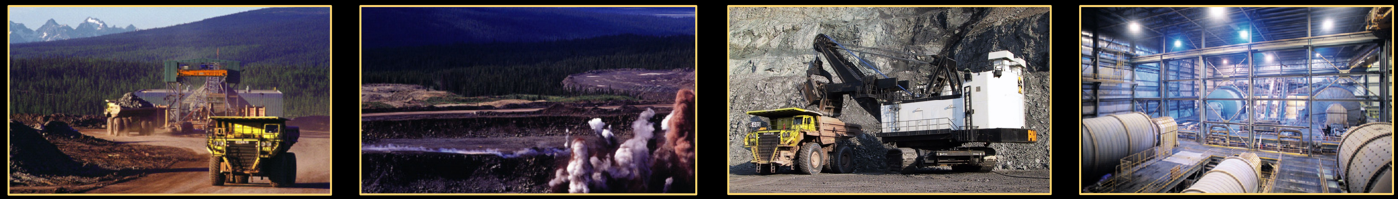


Field Leach Cell Results Materials Weathering

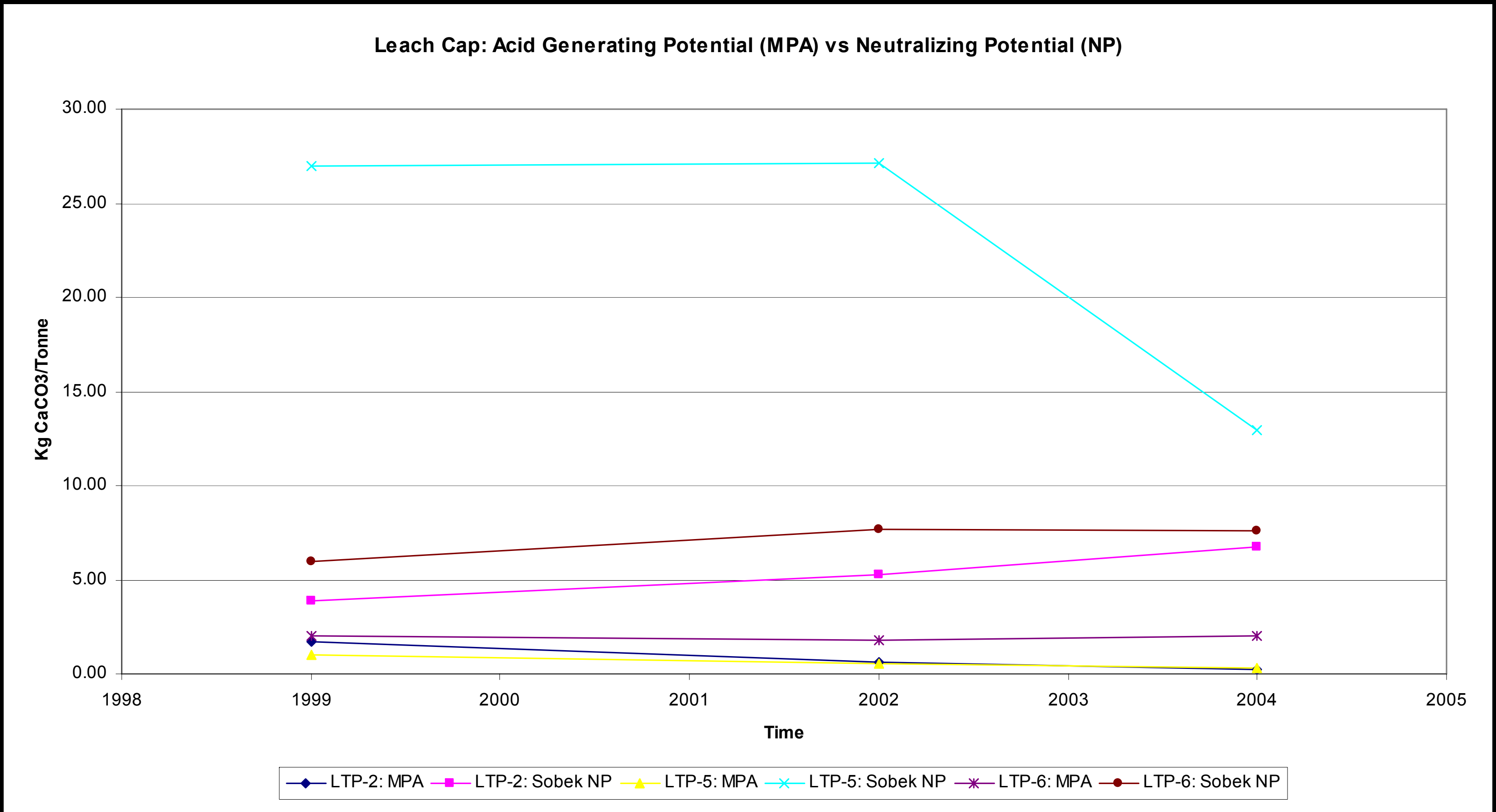


Field Leach Cell Results Materials Weathering





Field Leach Cell Results Materials Weathering



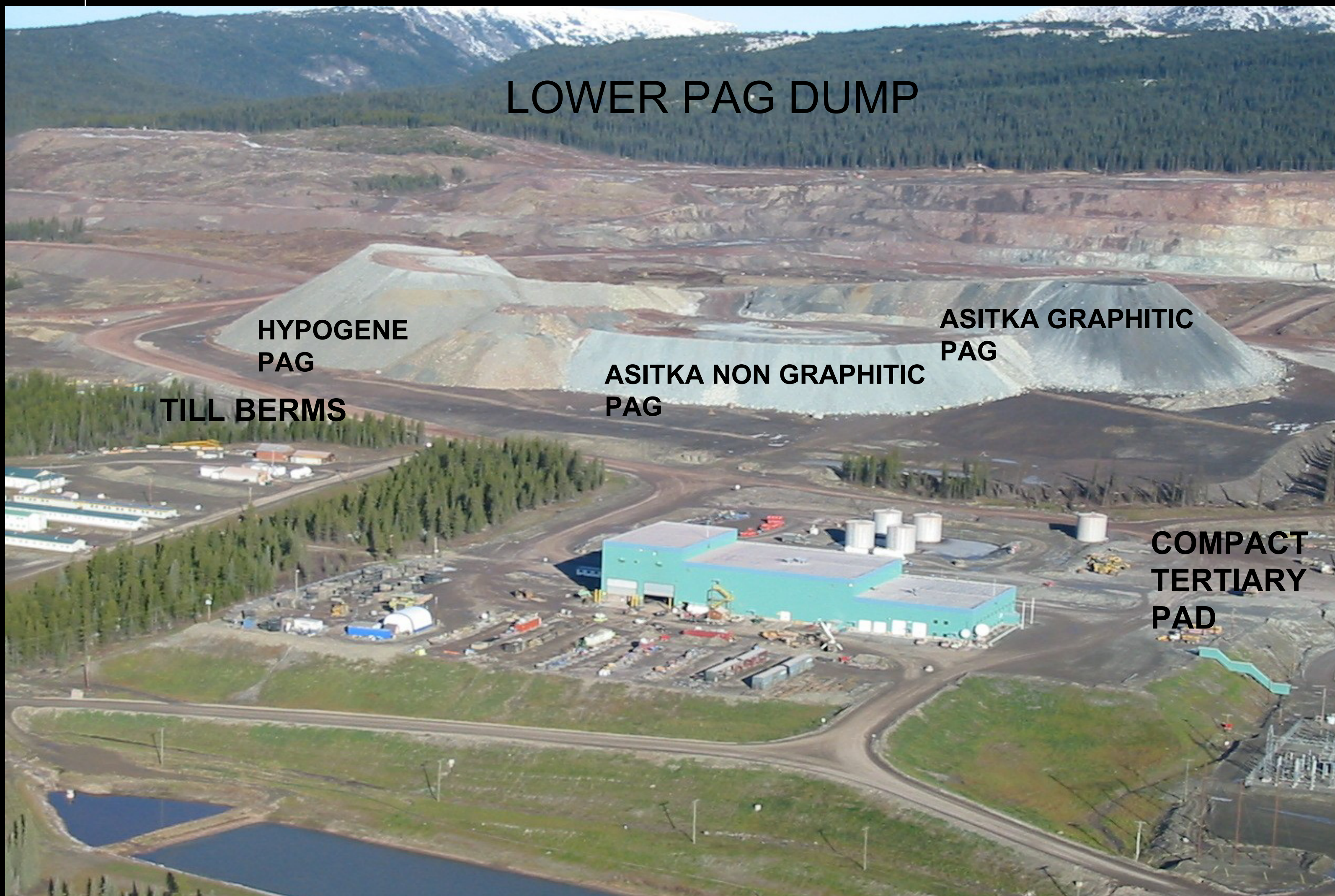


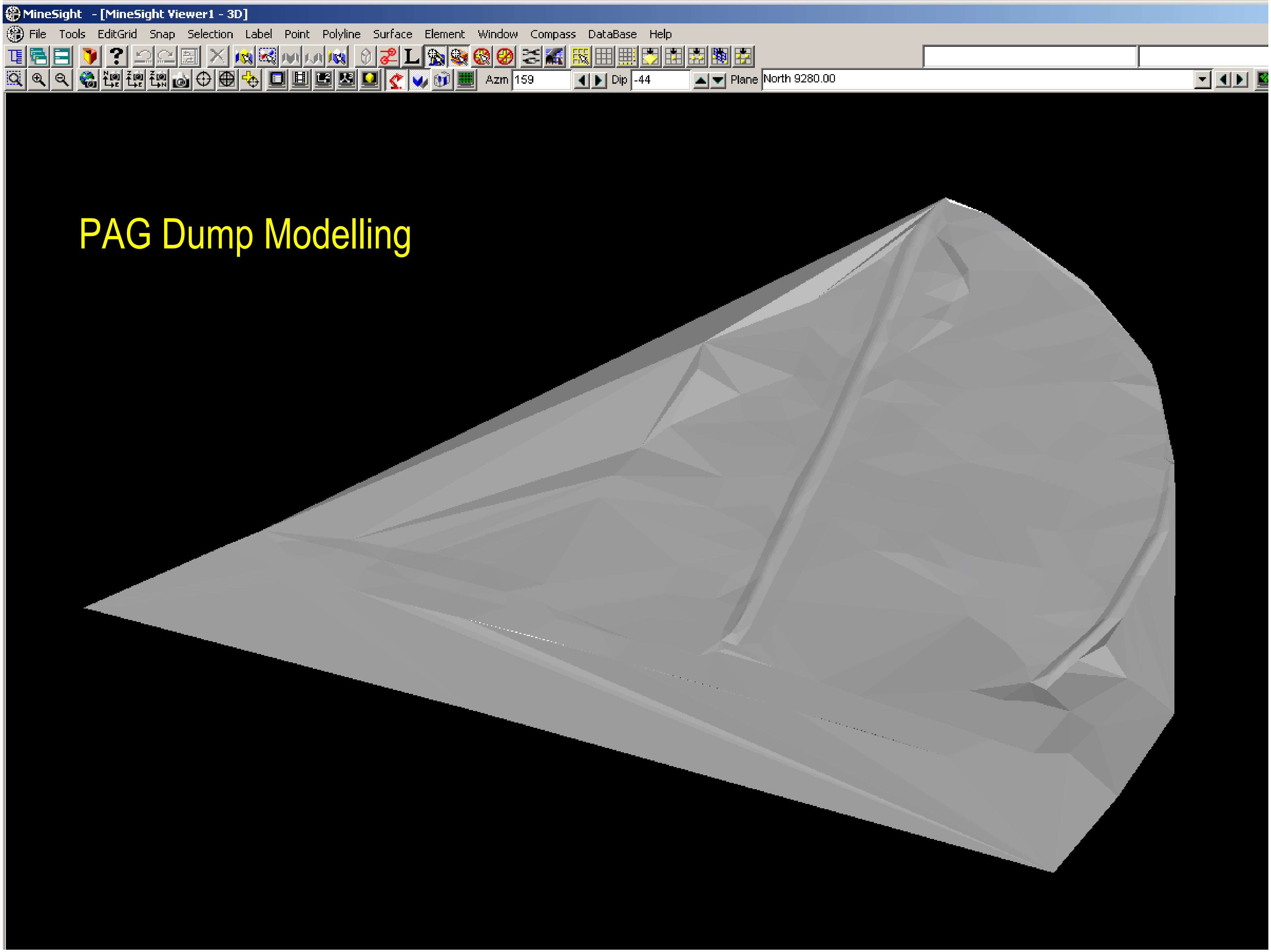

ARD/ML Modeling and Prediction

- Modeling is being conducted on stockpiles and areas of exposed sulphidic materials in the areas of the open pit and the Tailings Storage Facility,
- Models are developed both in-house and by third party consulting companies for materials tracking and predictive purposes,
- The prediction of post-closure water quality forms Condition 12 of the mine operating permit M-206,
- 3-D block models of the waste dumps are used to track components of the dumps.




KEMESS


LOWER PAG DUMP
HYPOGENE PAG
ASITKA GRAPHITIC PAG
ASITKA NON GRAPHITIC PAG
TILL BERMS
COMPACT TERTIARY PAD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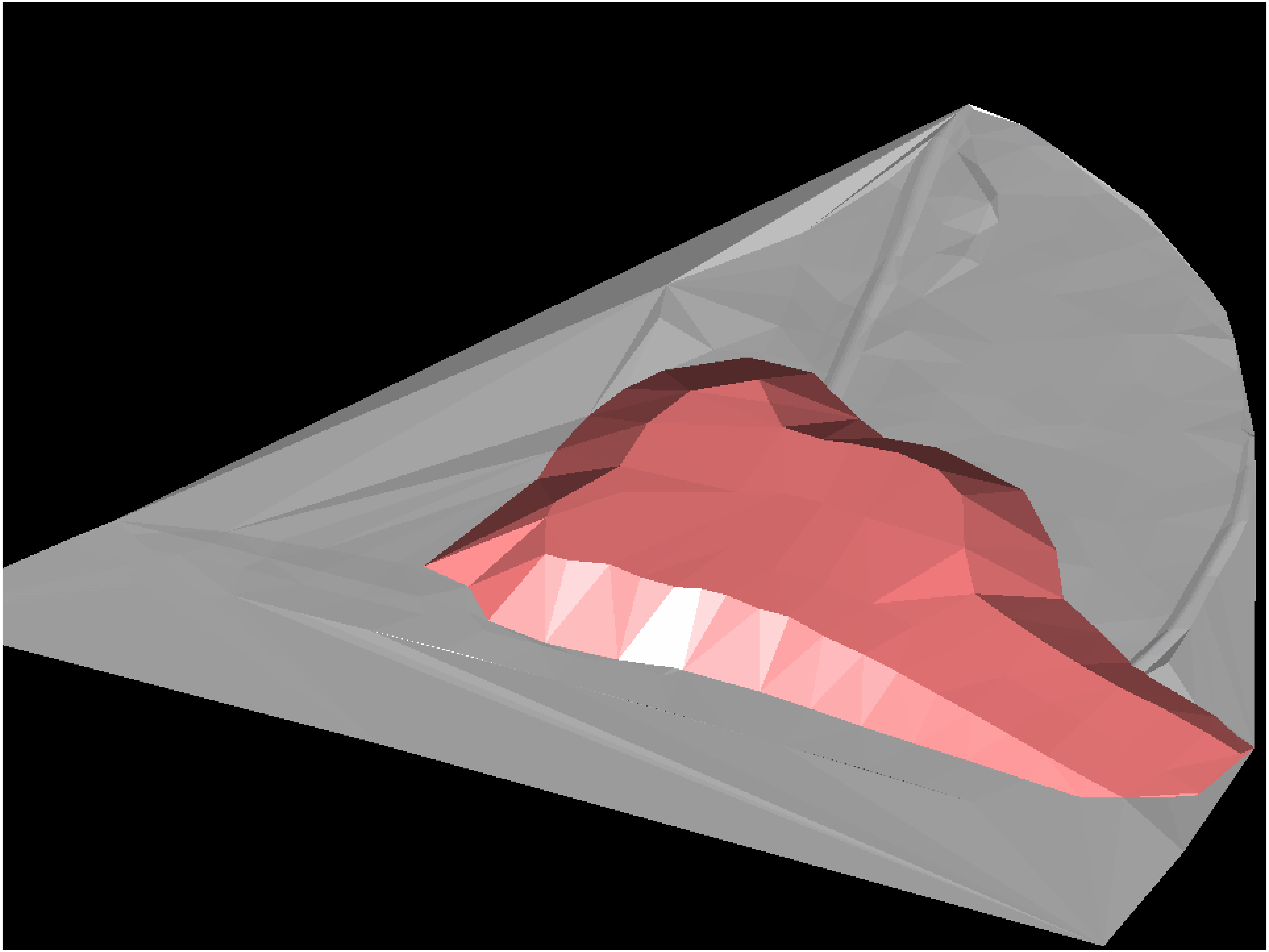
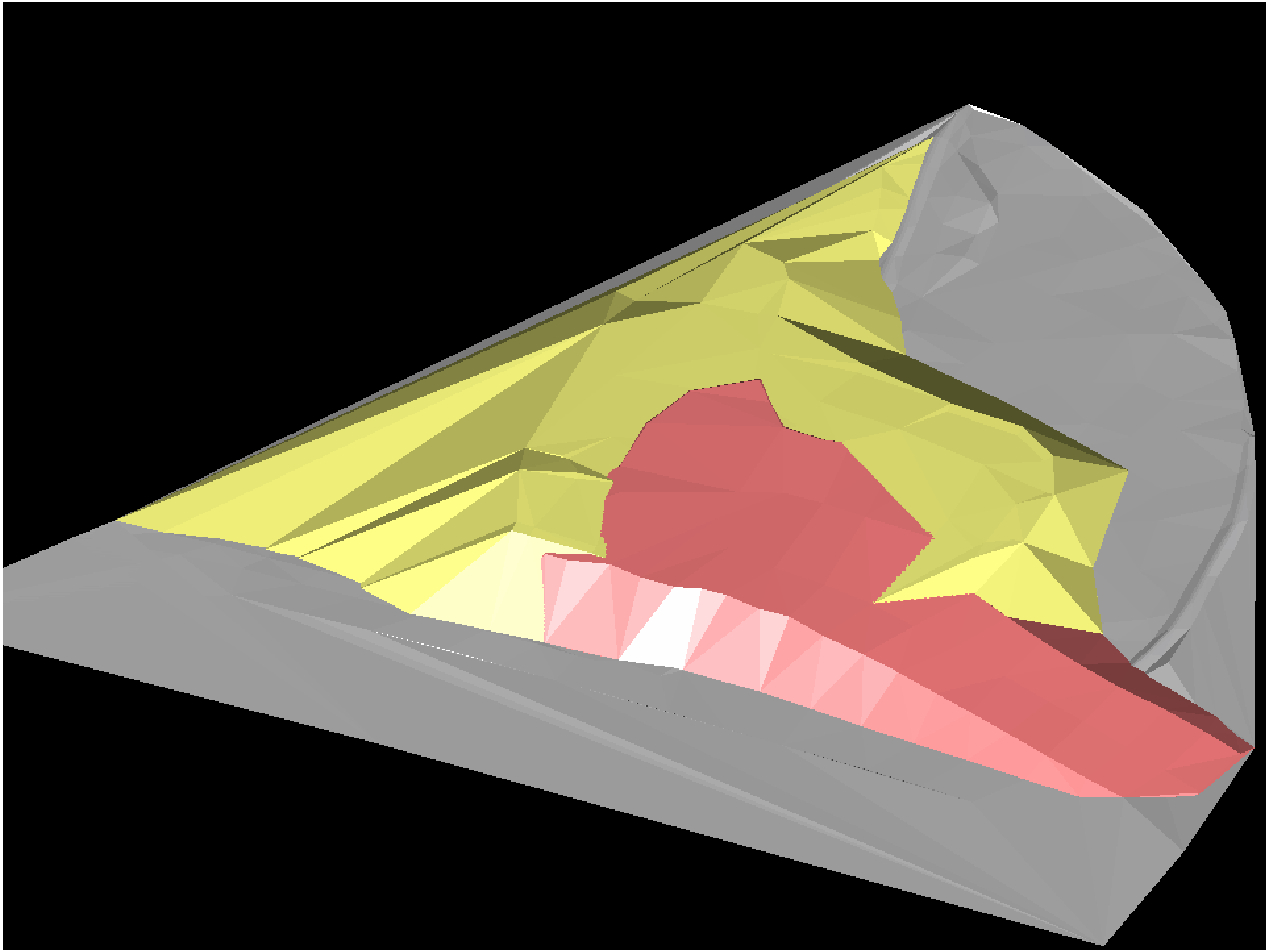
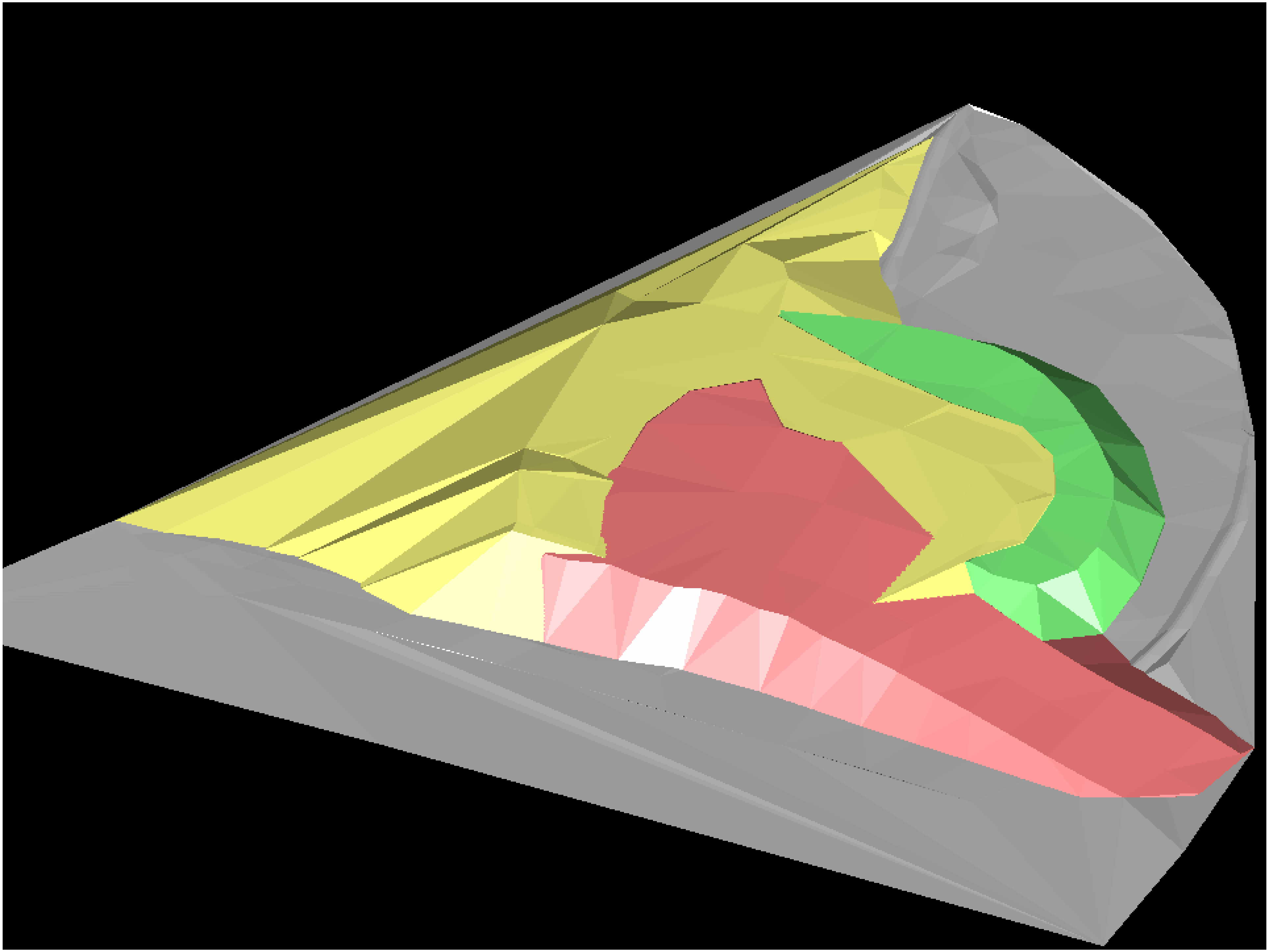
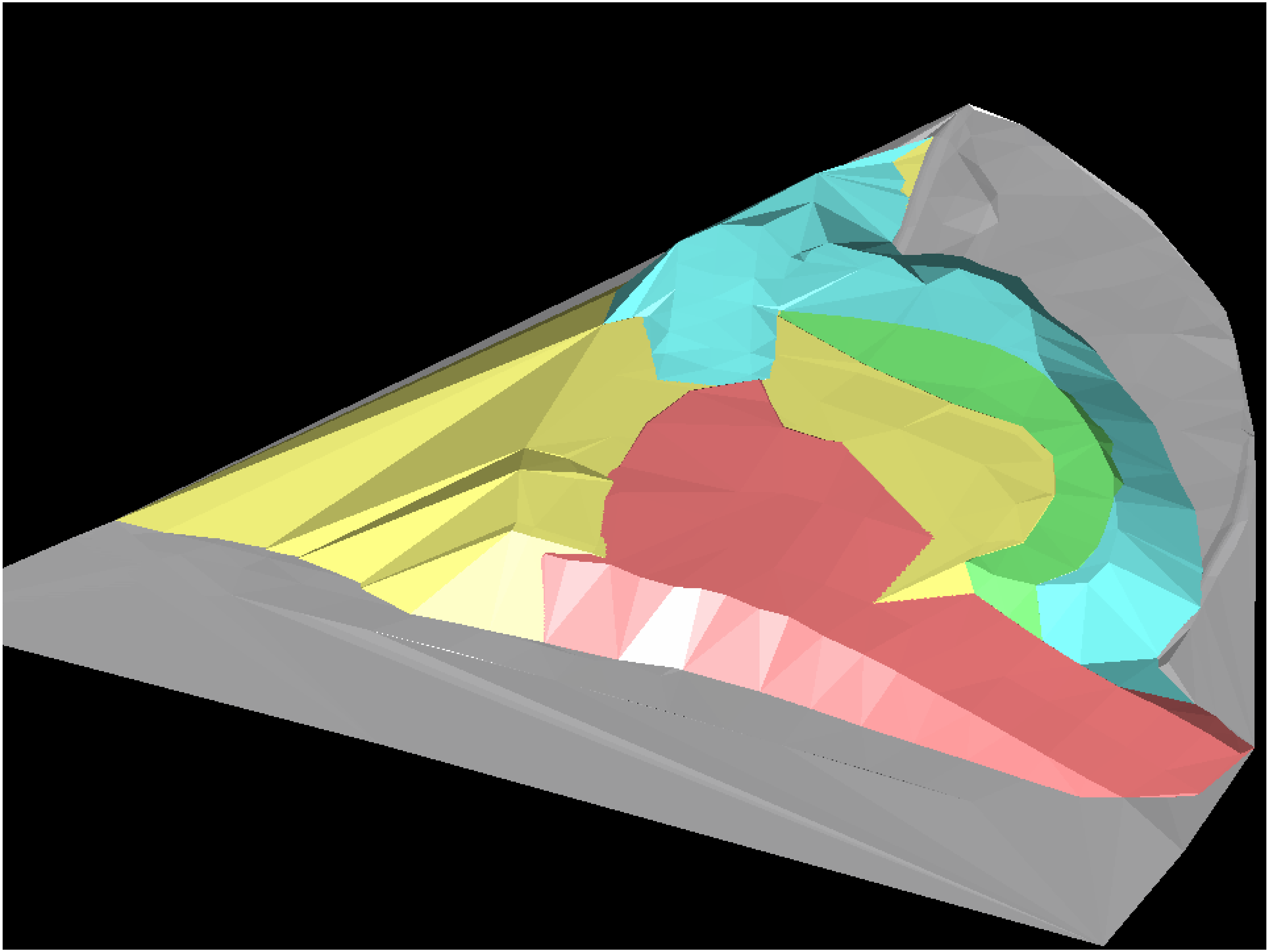
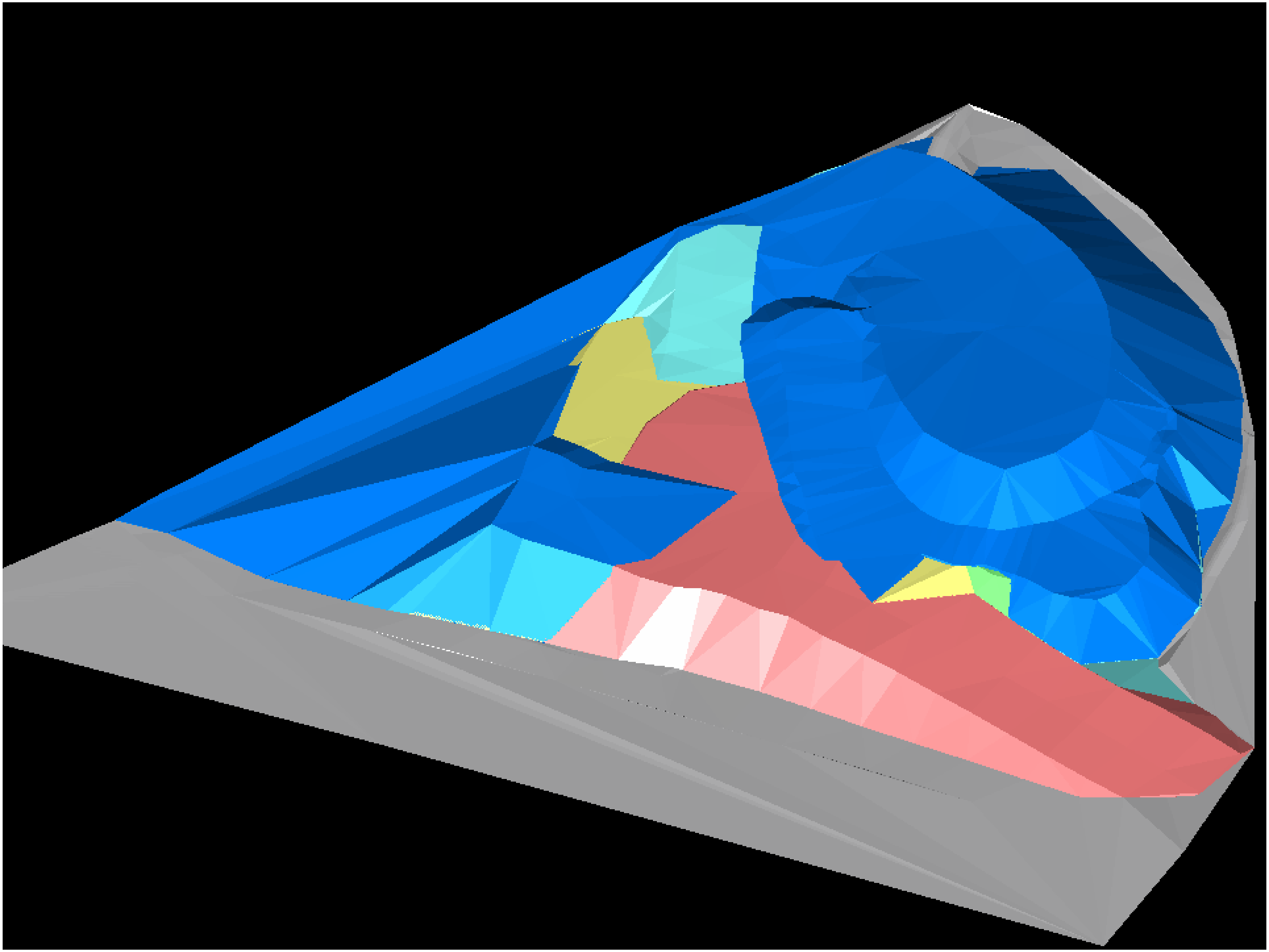
PAG Dump Modelling

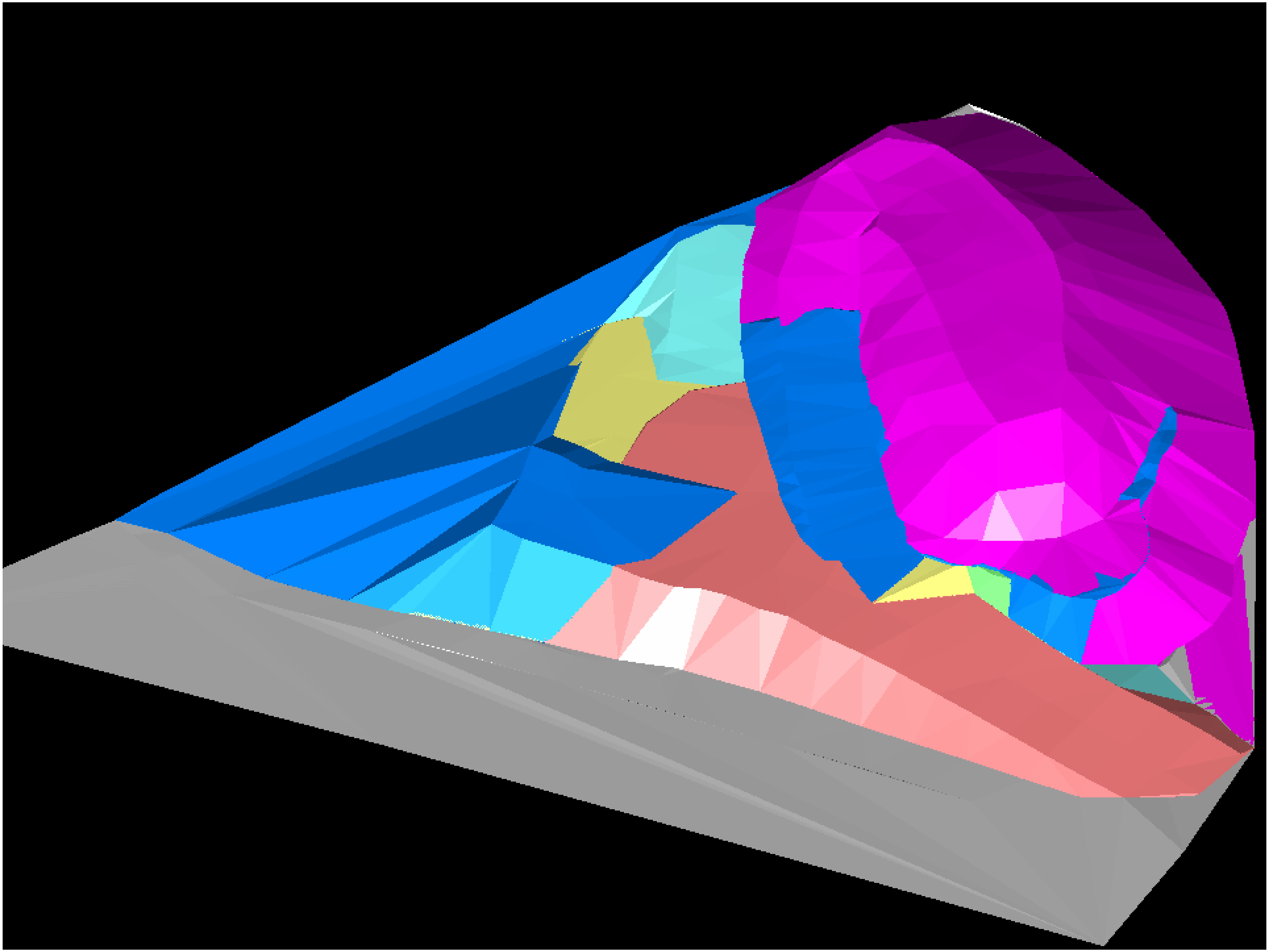


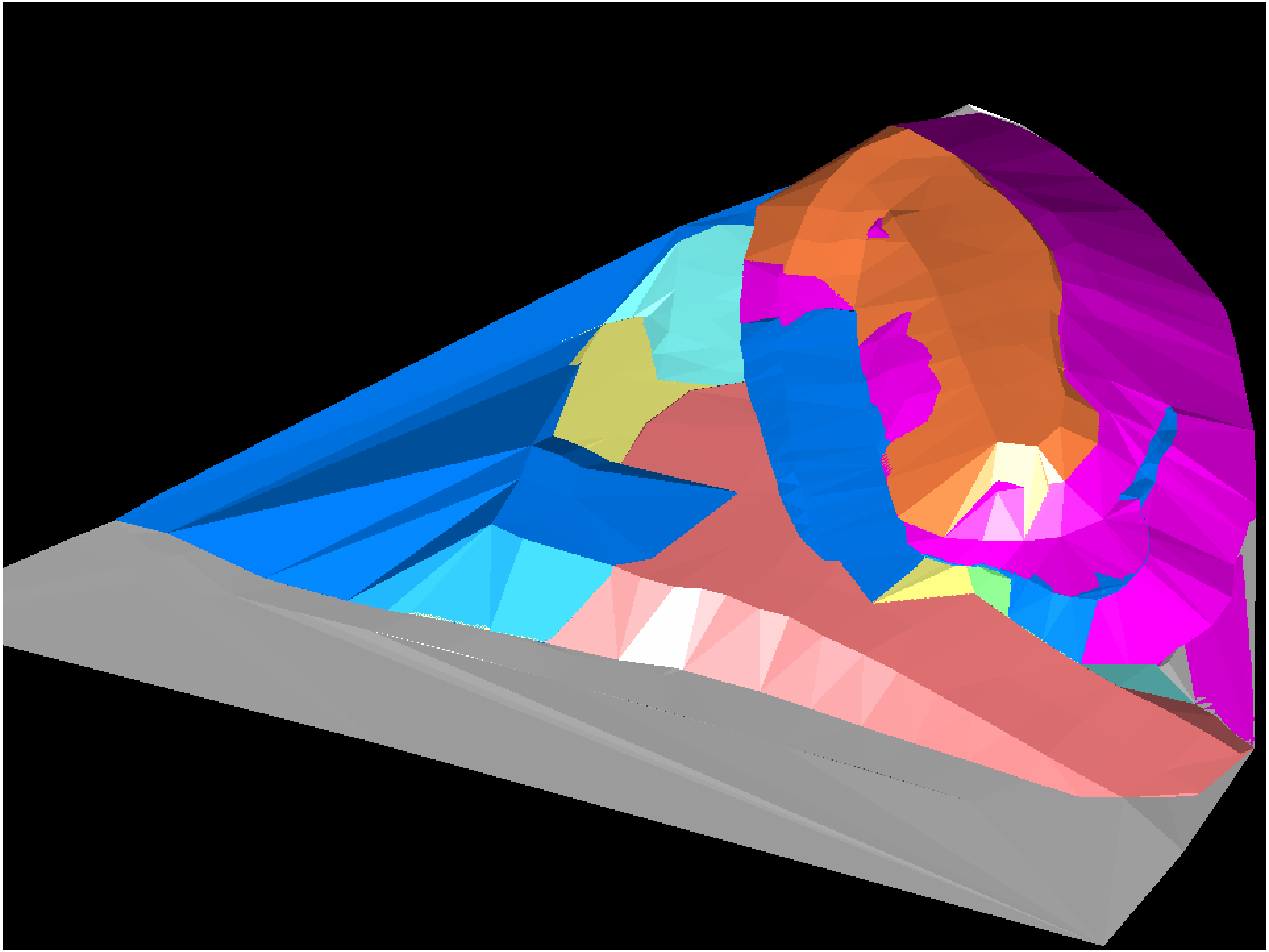


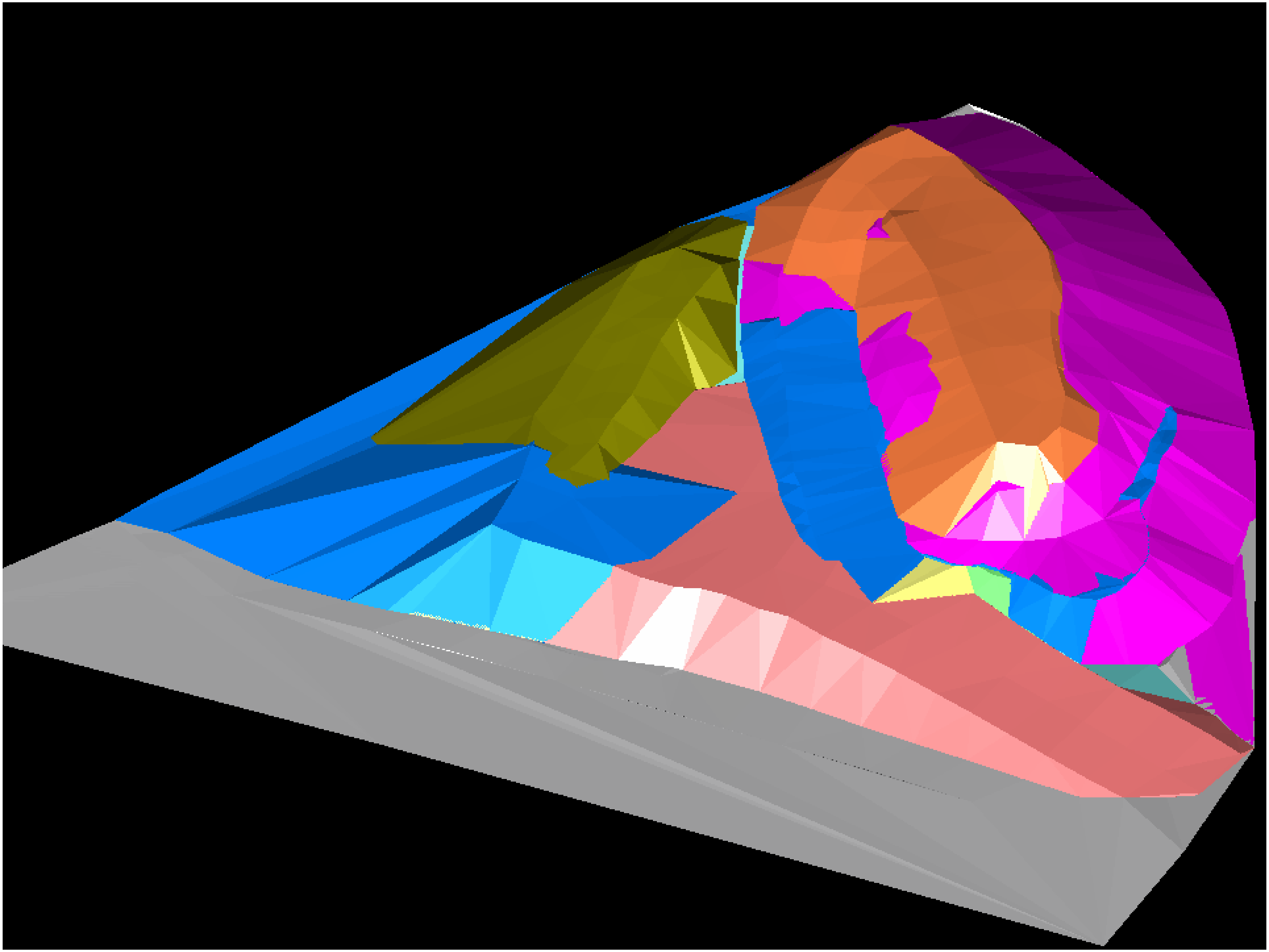


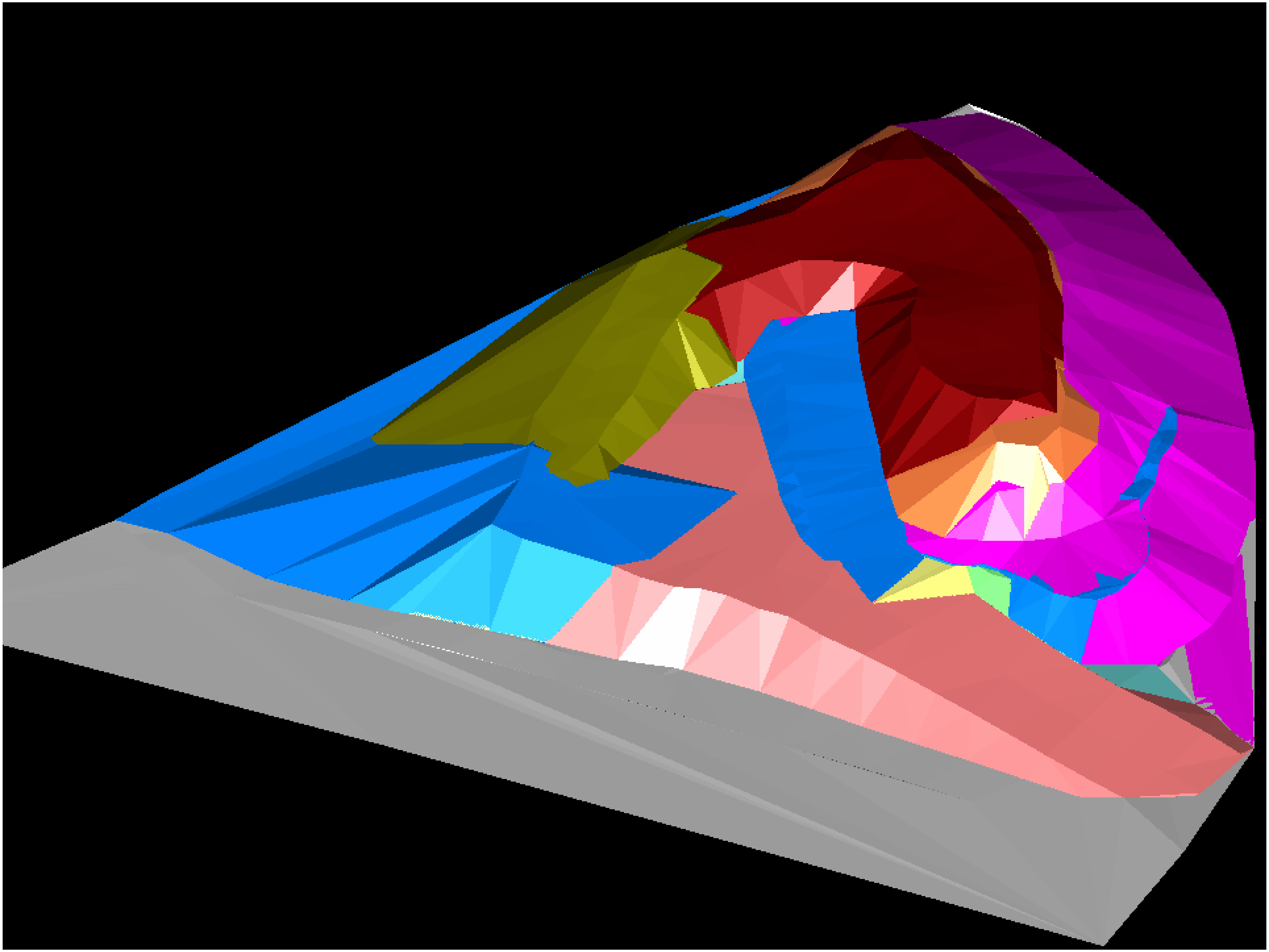


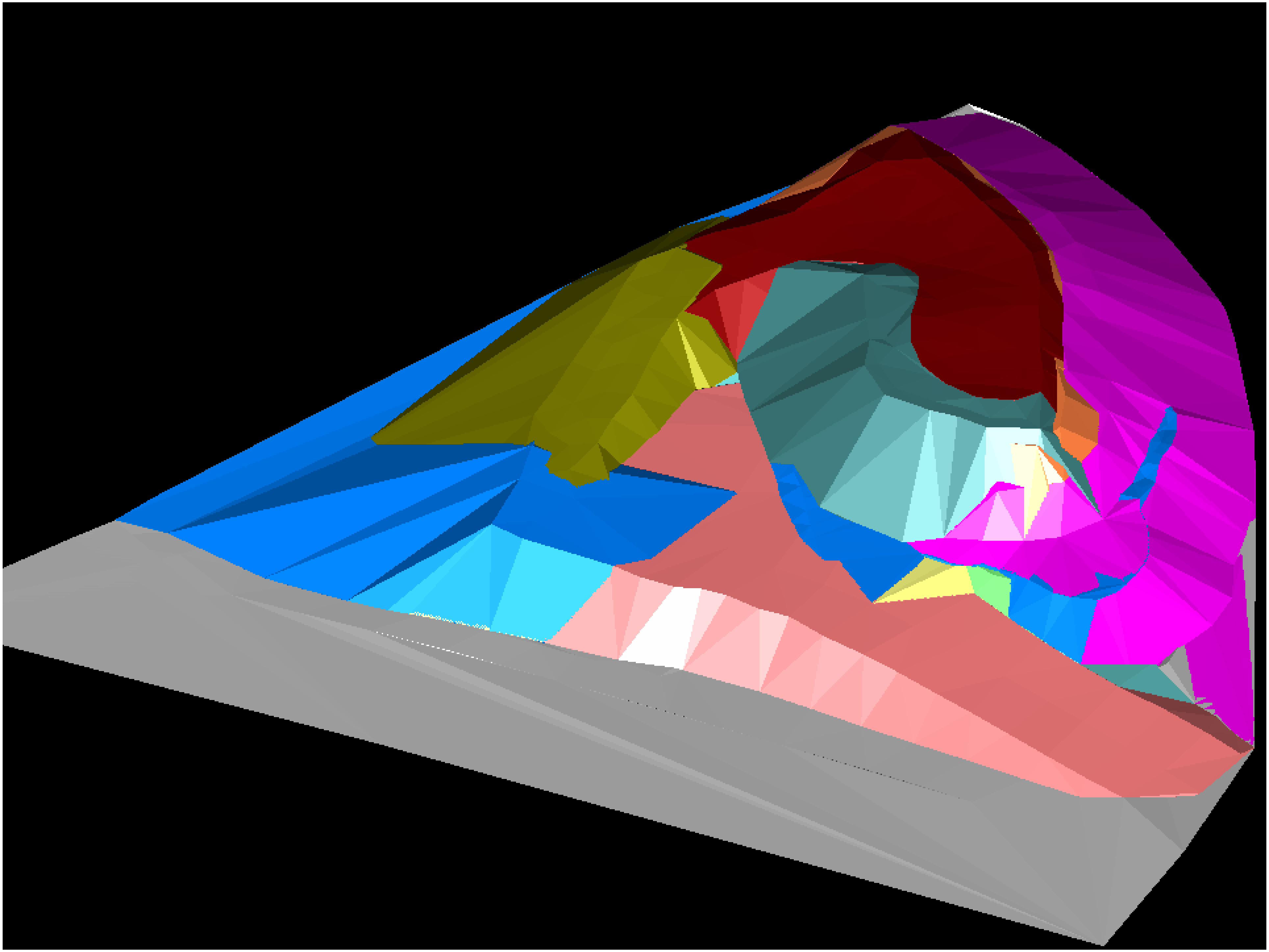


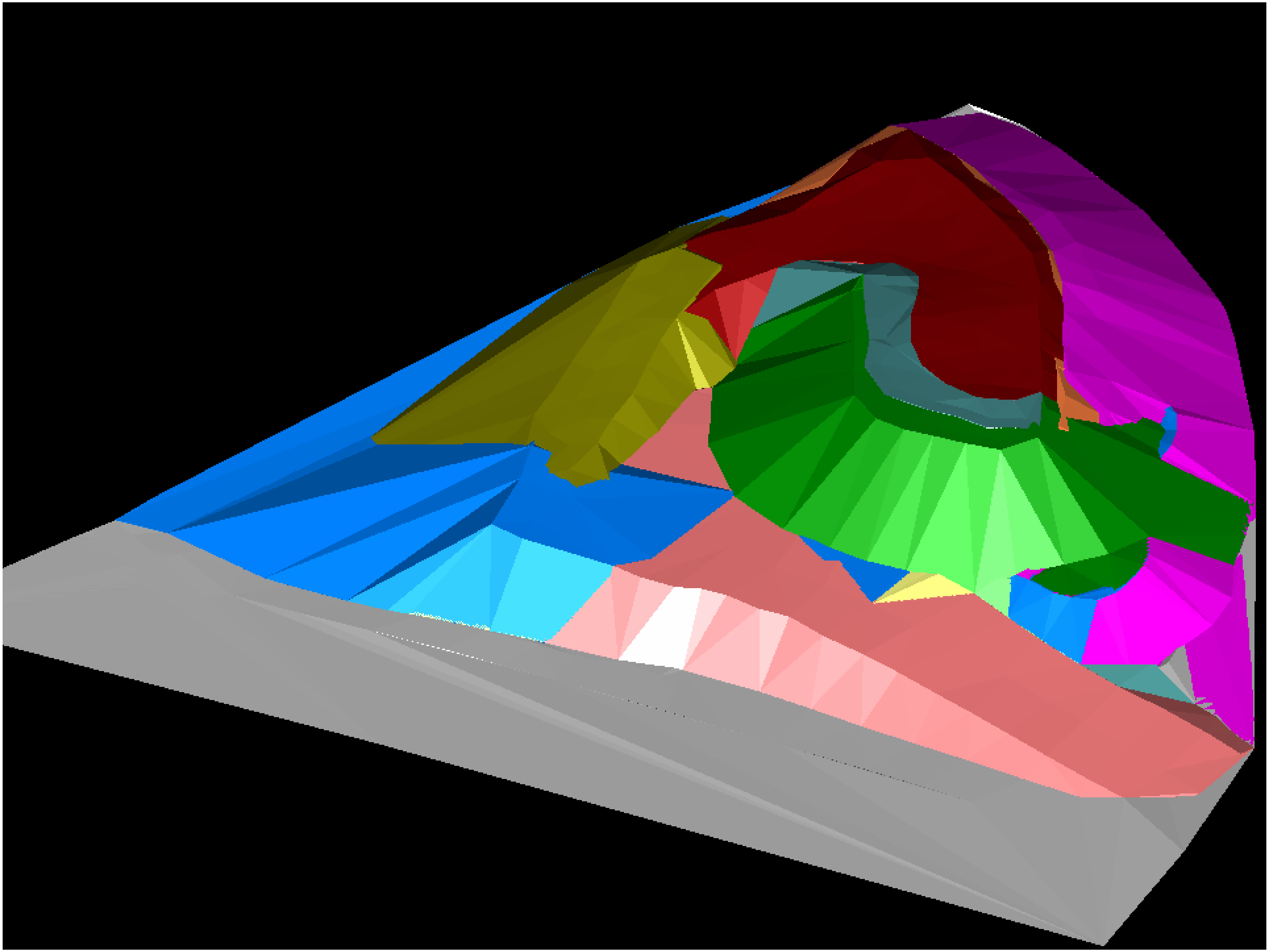


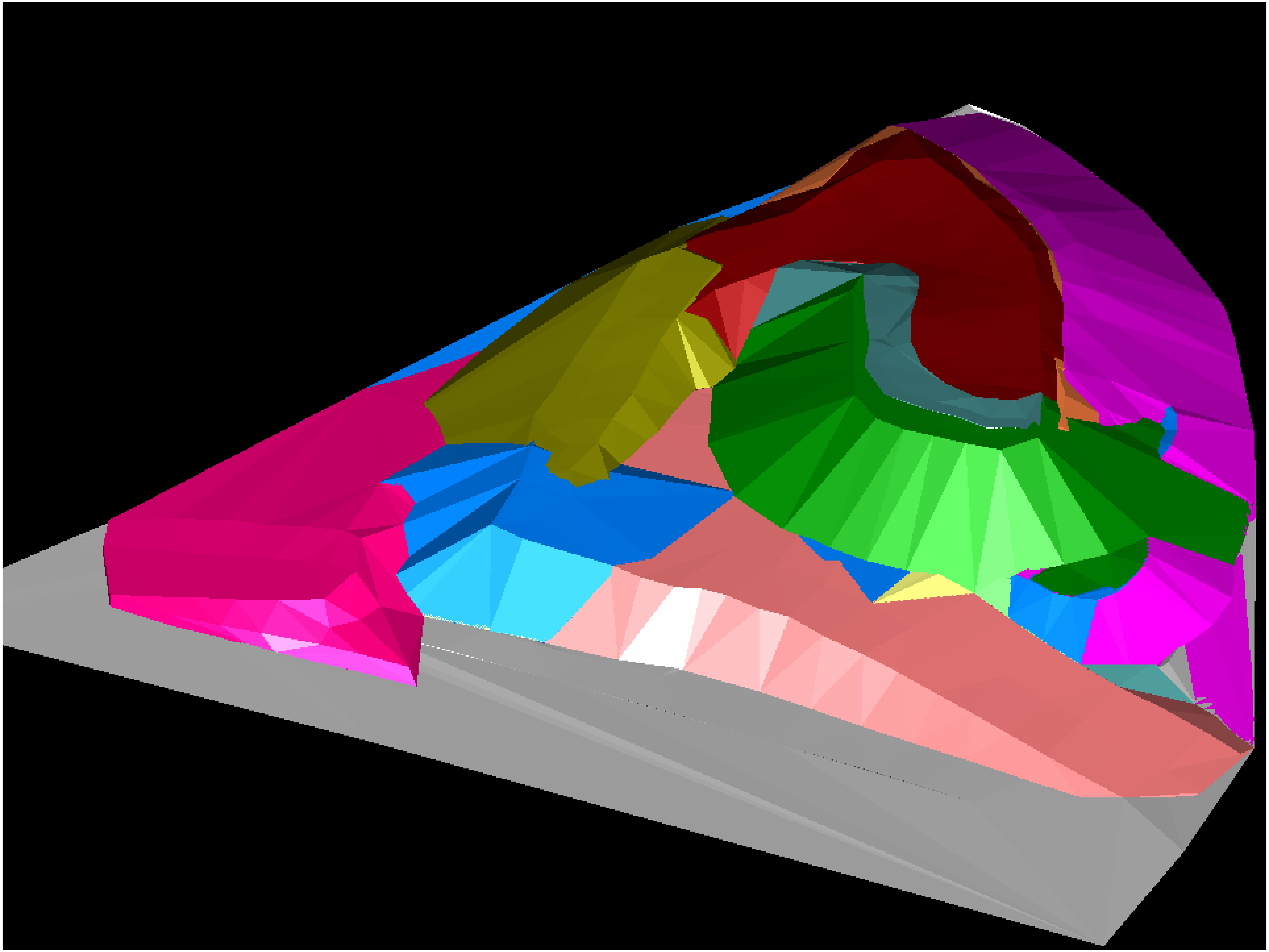


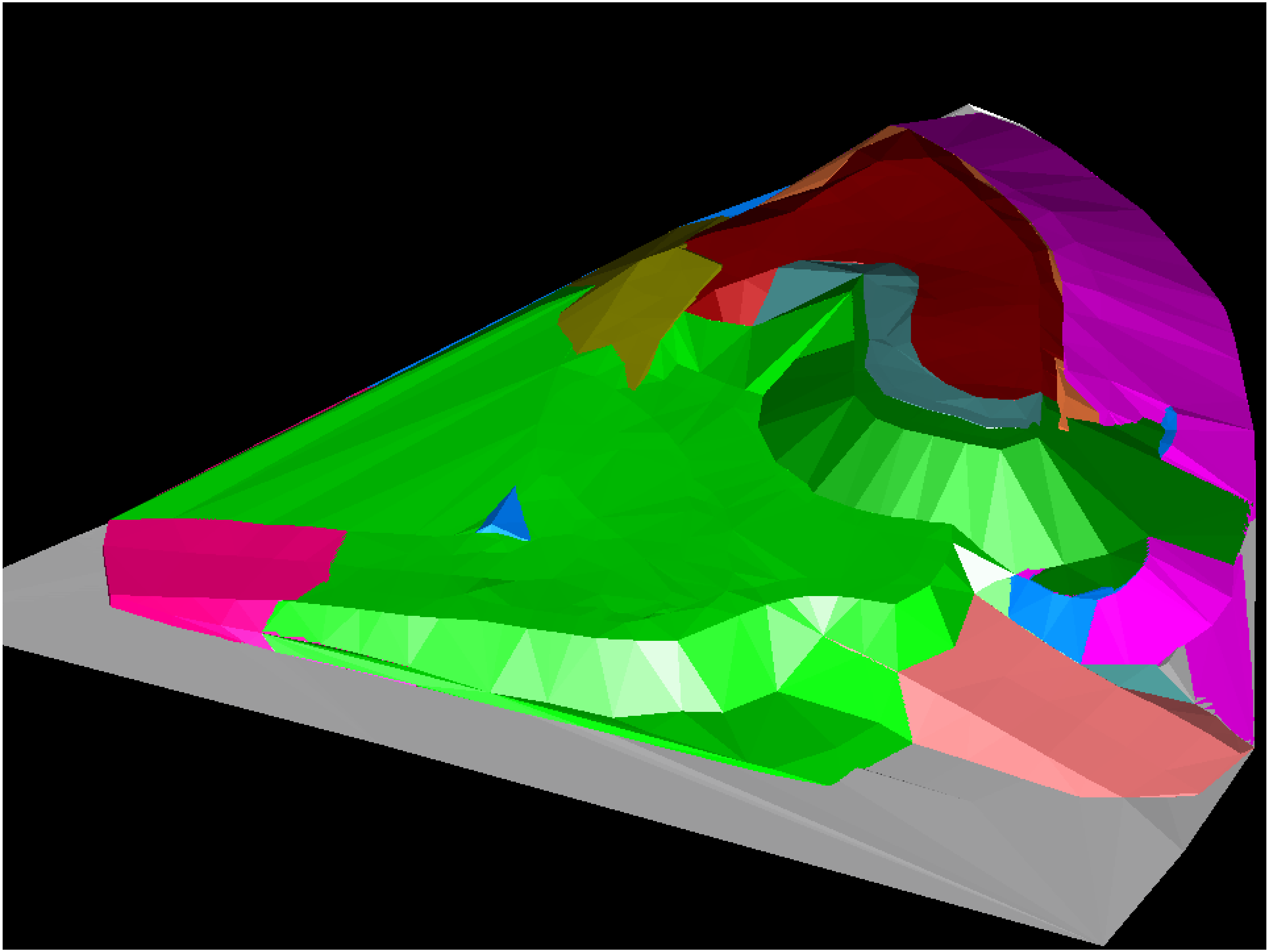


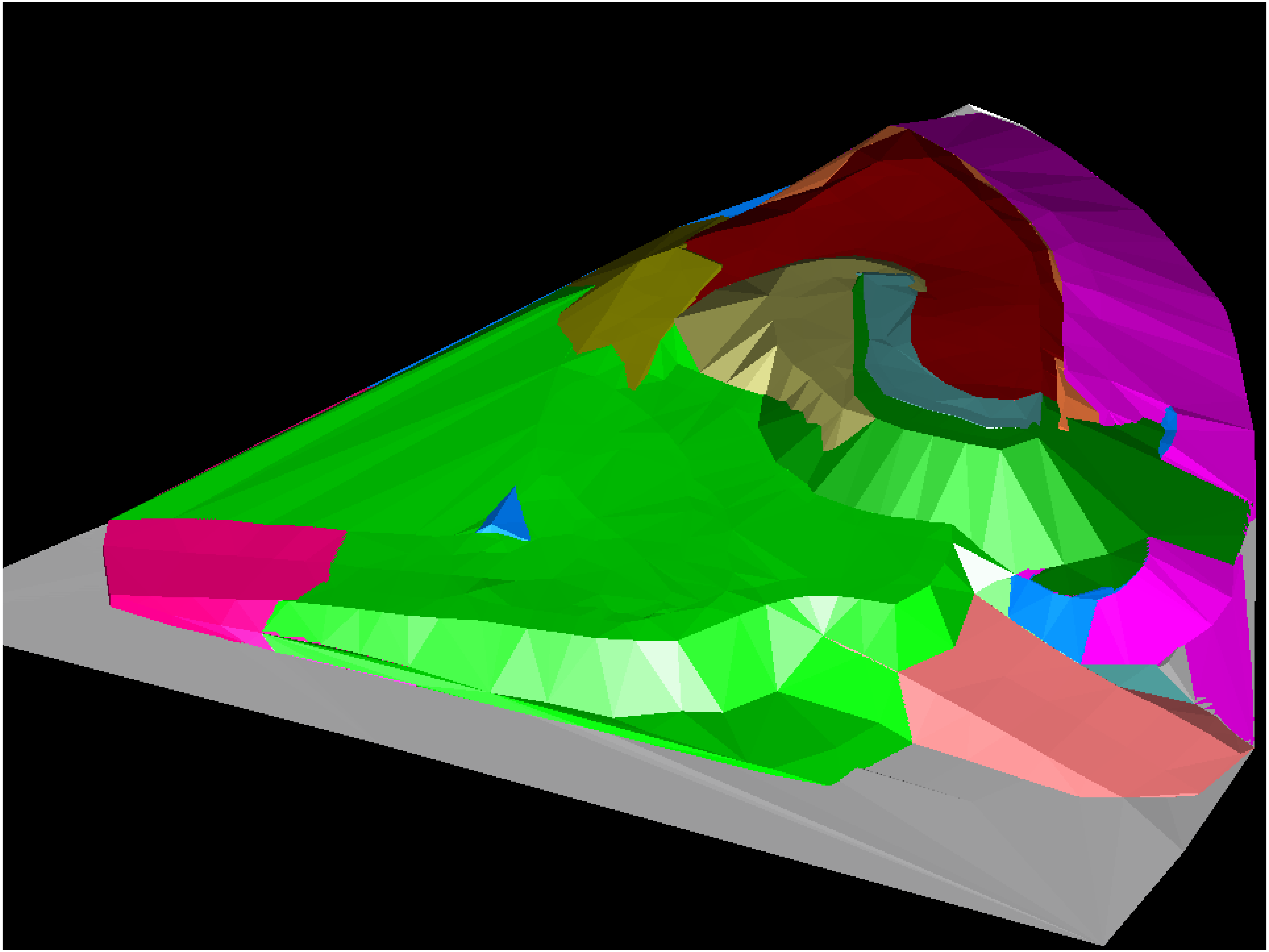


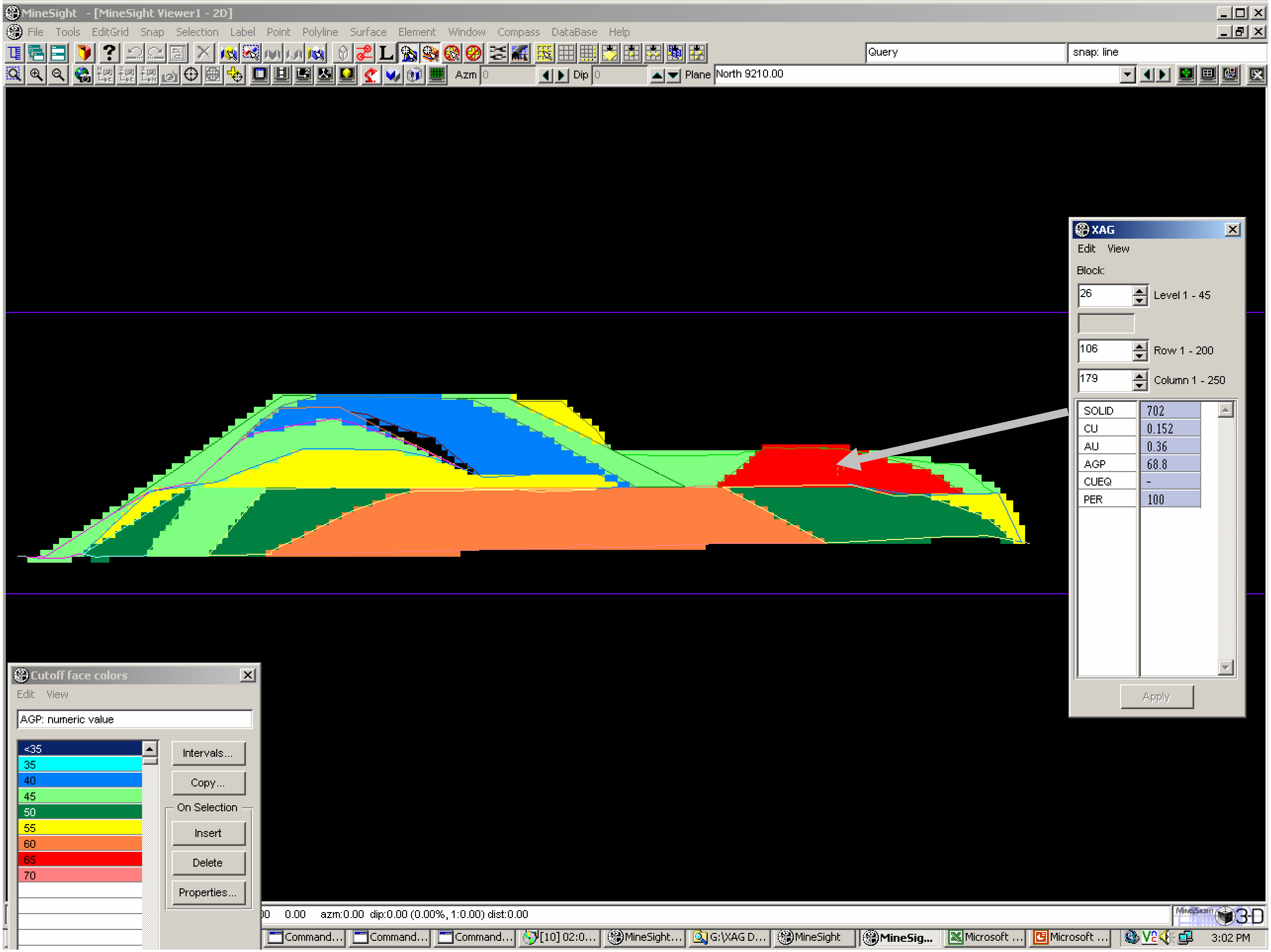








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Dip 0
Plane North 9210.00
XAG
Edit View
Block:
26 Level 1 - 45
106 Row 1 - 200
179 Column 1 - 250
SOLID 702
CU 0.152
AU 0.36
AGP 68.8
CUEQ -
PER 100
Apply
Cutoff face colors
Edit View
AGP: numeric value
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35
40
45
50
55
60
65
70
Intervals...
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On Selection
Insert
Delete
Properties...
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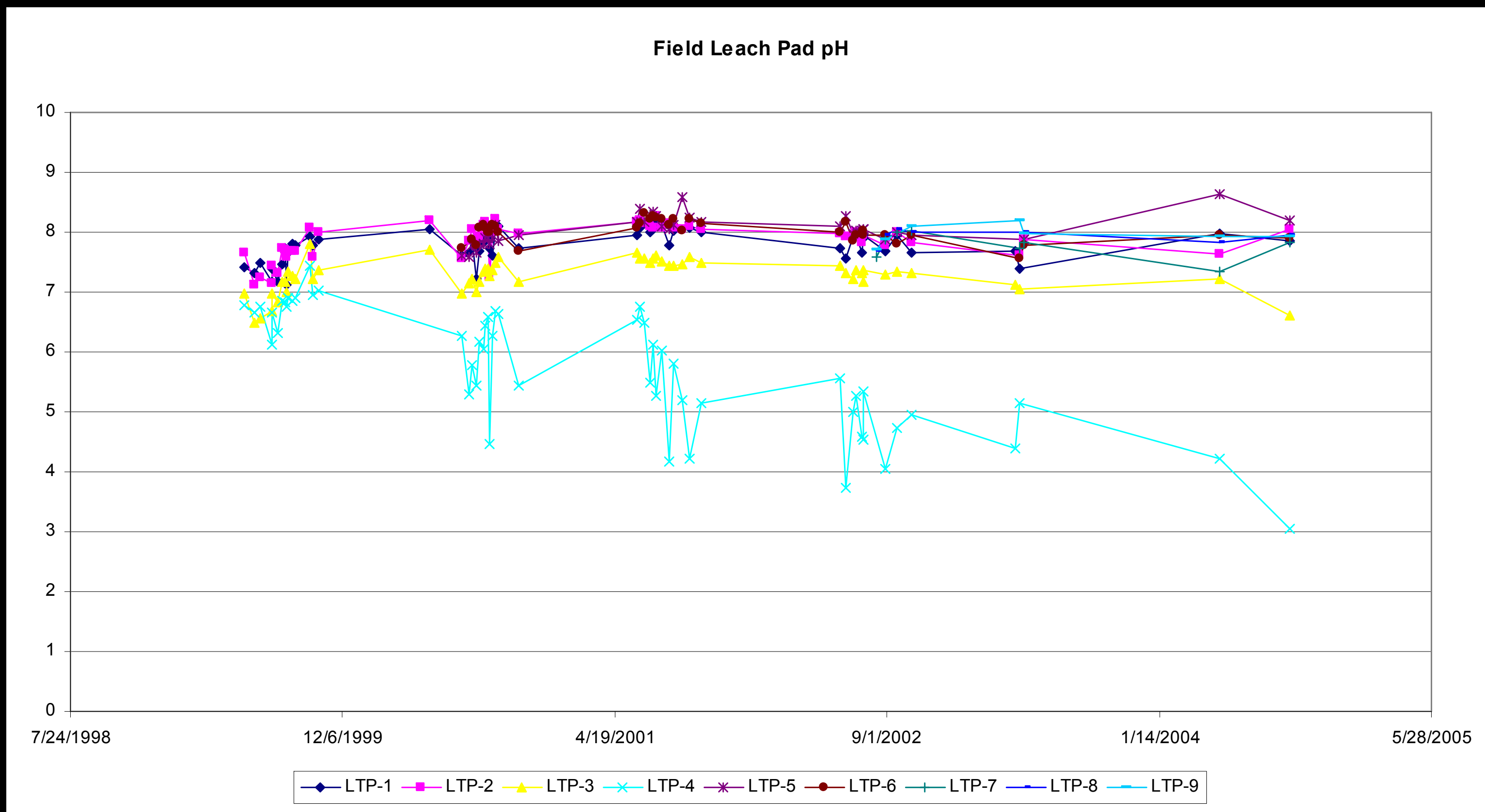
3:02 PM




Case Study – Graphitic Asitka Material Handling

- Testing showed graphitic Asitka (GAG) material to be acid generating with a short estimated time to acidity (<8 years),
- Field pads of material showed evidence of acid generation within 2 years of establishment,
- Aerial storage pad containing approximately 4 million tonnes of graphitic PAG started in early 2002. Dump has been observed since construction for evidence of acid generation with possible vents noted during 2004 and 2005,
- Decision made to co-dispose of stockpiled GAG in a blended NAG/GAG dump in the eastern portion of the open pit. Sampling to be conducted during the excavation of the GAG materials to allow for determination of the ARD status of different portions of the GAG dump.



Field Leach Pad pH
10
9
8
7
6
5
4
3
2
1
0
7/24/1998
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005
LTP-1
LTP-2
LTP-3
LTP-4
LTP-5
LTP-6
LTP-7
LTP-8
LTP-9







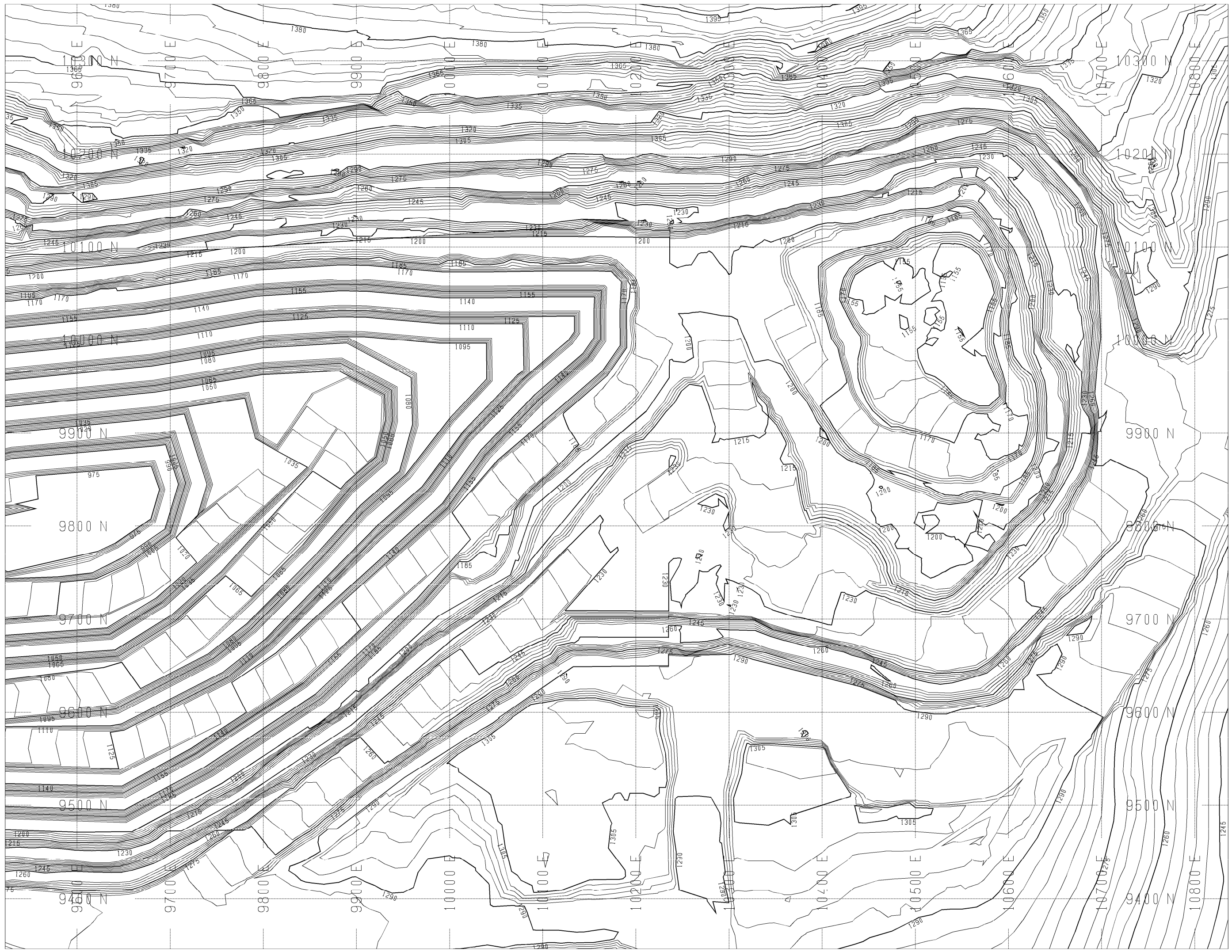



GAG
2005 11 5



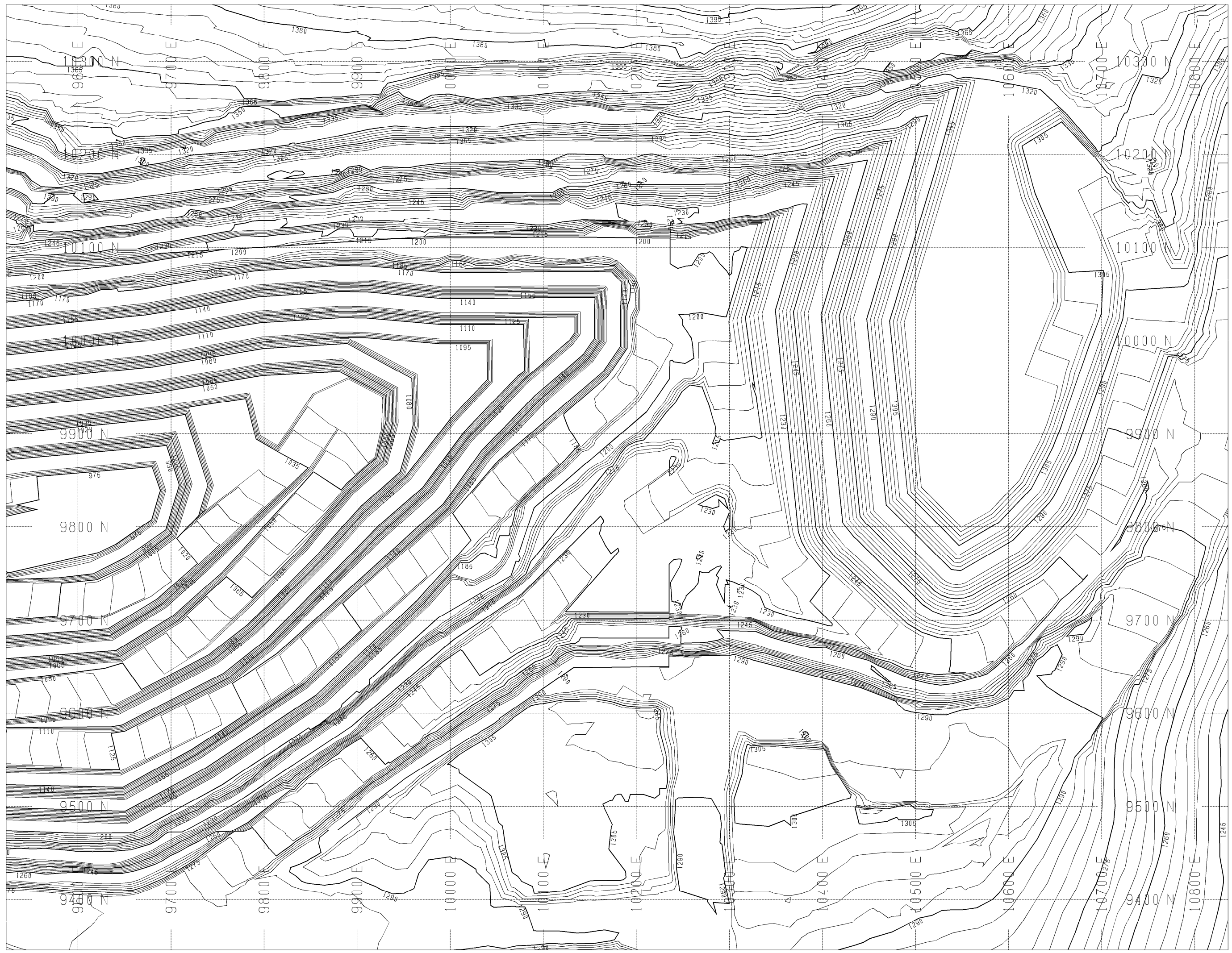

KEMESS

Final Pit without East End Dump






Final Pit with East End dump






East Side of Pit from West Side

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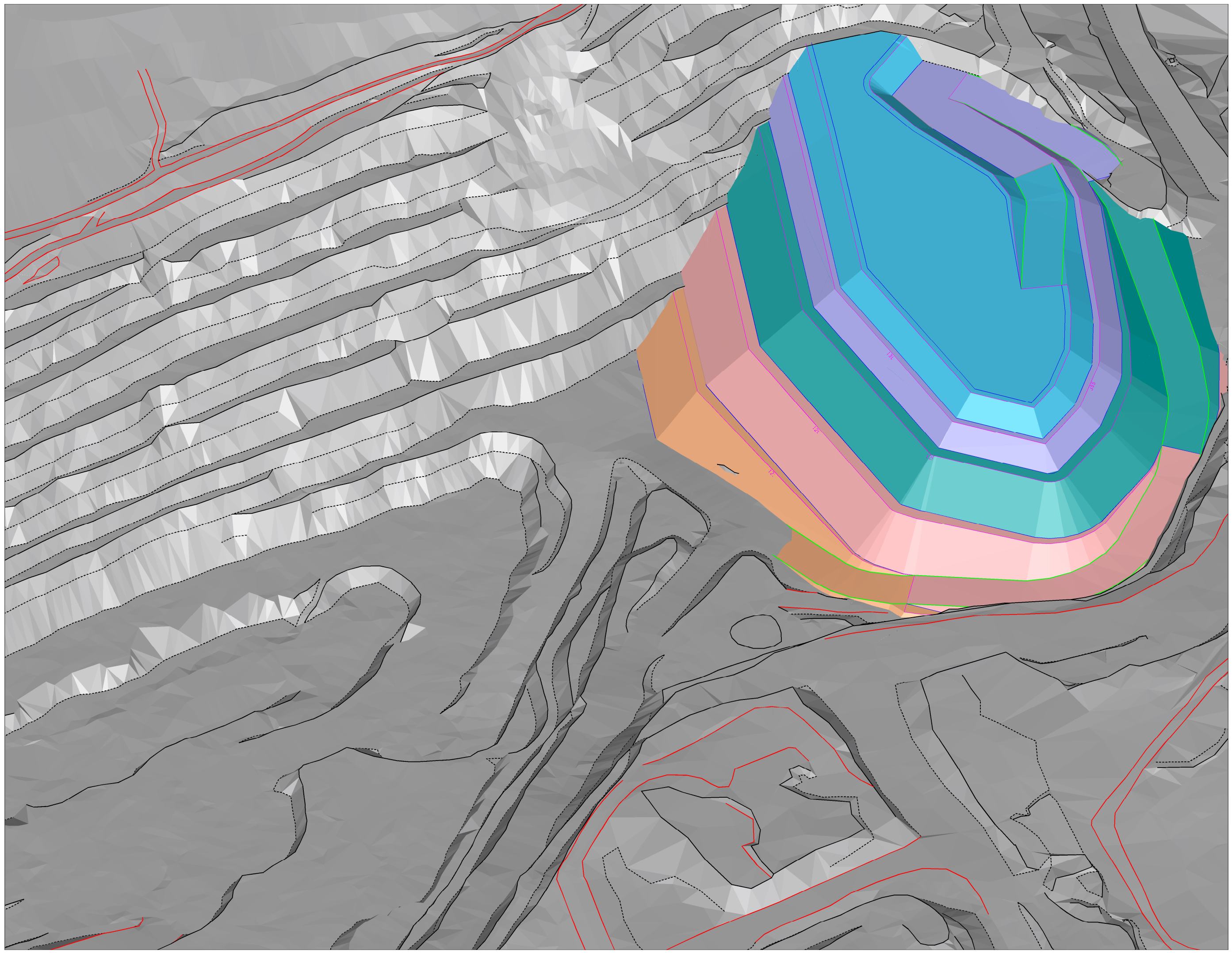
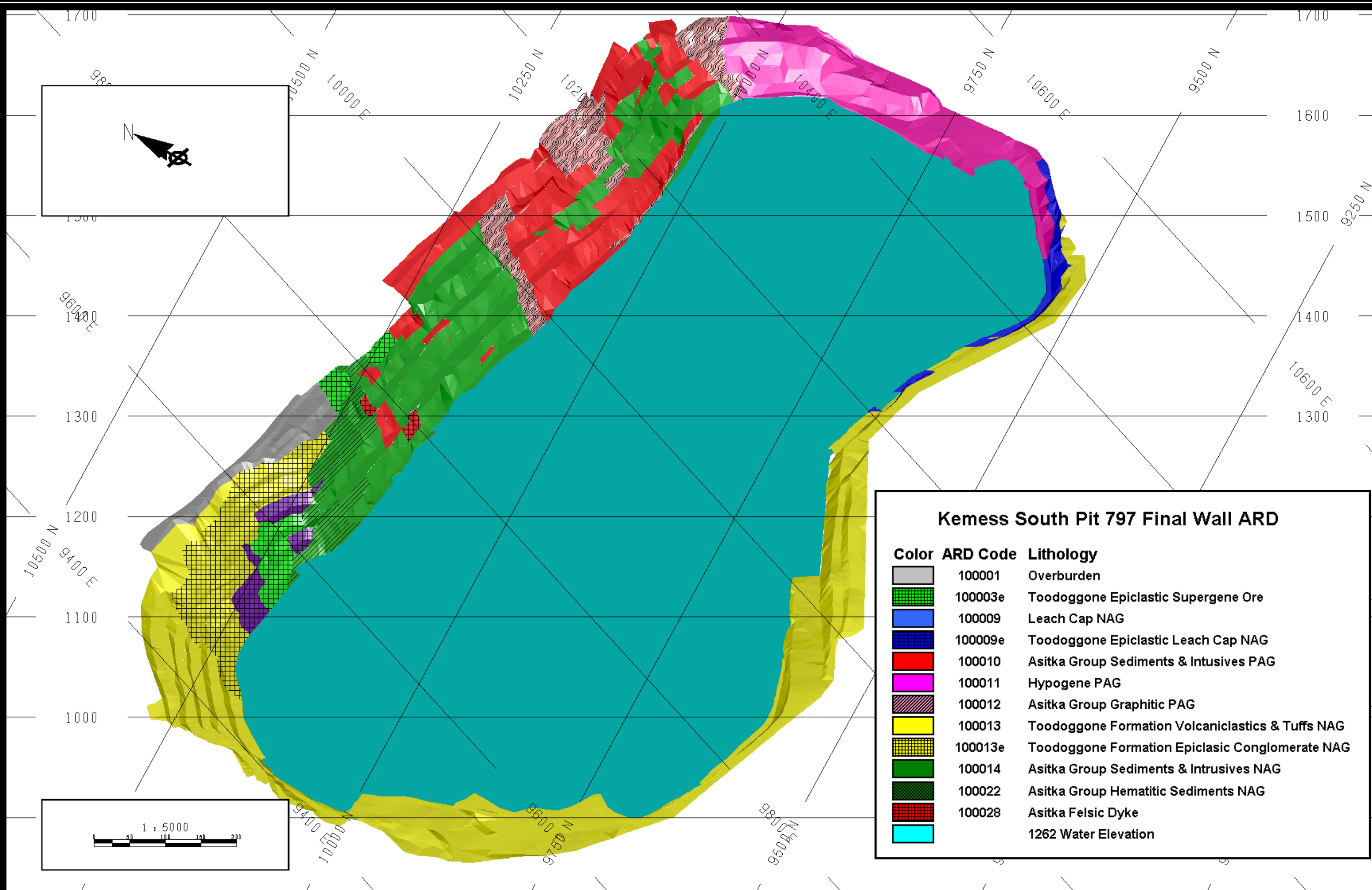
KEMESS

East Dump Plan







Kemess South Pit 797 Final Wall ARD
Color ARD Code Lithology
100001 Overburden
100003e Toodoggone Epiclastic Supergene Ore
100009 Leach Cap NAG
100009e Toodoggone Epiclastic Leach Cap NAG
100010 Asitka Group Sediments & Intusives PAG
100011 Hypogene PAG
100012 Asitka Group Graphitic PAG
100013 Toodoggone Formation Volcaniclastics & Tuffs NAG
100013e Toodoggone Formation Epiclasic Conglomerate NAG
100014 Asitka Group Sediments & Intrusives NAG
100022 Asitka Group Hematitic Sediments NAG
100028 Asitka Felsic Dyke
1262 Water Elevation
N
1 : 5000
1700
1600
1500
1400
1300
1200
1100
1000
10250 N
10000 E
9750 N
10600 E
9500 N
9250 N
10500 N
9400 E
9600 E




Conclusion

- A comprehensive, workable permit is possible when the mining company and regulatory agencies work together.
- Well directed and focused testwork can result in substantial cost savings and an environmentally balanced mine.
- Planning is key to insure environmental viability and profitability.