



HALLUX

TALON™

OIL SERVICES

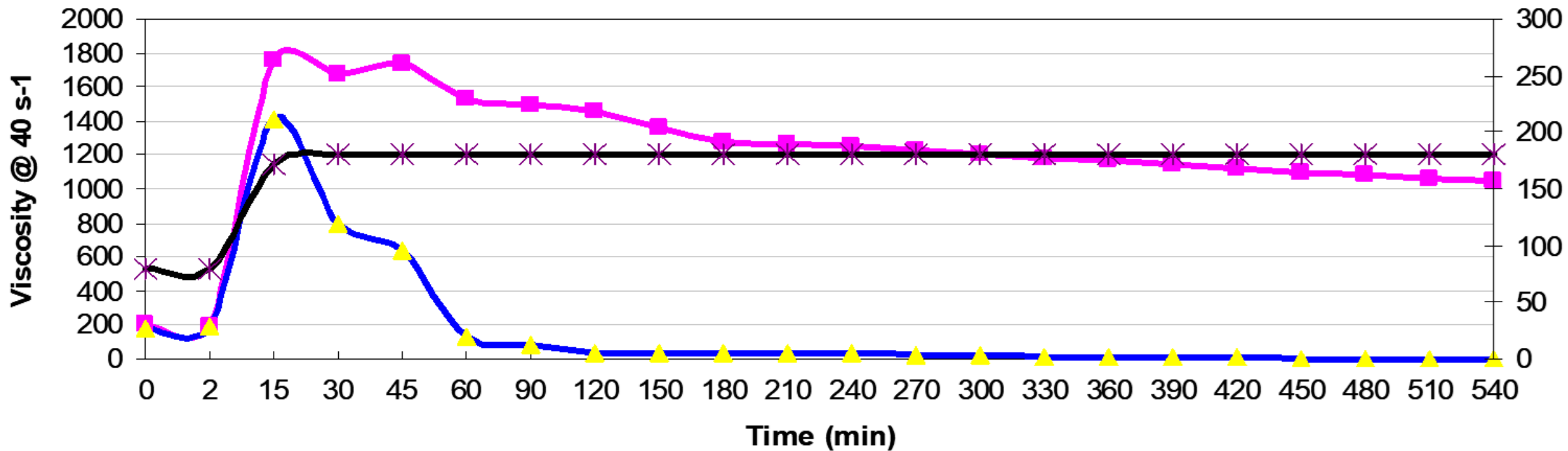
Enzyme(s): Properties

- ◆ Large, highly specialized proteins produced by living cells
- ◆ Enzymes act as catalysts to speed-up chemical reactions
- ◆ Highly specific towards their substrate
- ◆ Reaction rate controlled by pH, temperature, pressure
- ◆ Environmentally friendly

Enzyme Breaker Product Line

- ◆ Guar Enzyme HT
- ◆ Guar Enzyme HT Concentrate
- ◆ Guar Enzyme LT AHM-18
- ◆ Guar Enzyme LT Concentrate
- ◆ Cellulase Enzyme LT
- ◆ Cellulase Concentrate
- ◆ Starch Enzyme Concentrate
- ◆ Starch Enzyme Concentrate-19S
- ◆ Starch Enzyme Concentrate-42S
- ◆ Xanthanase Concentrate
- ◆ Xanthanase Super Concentrate

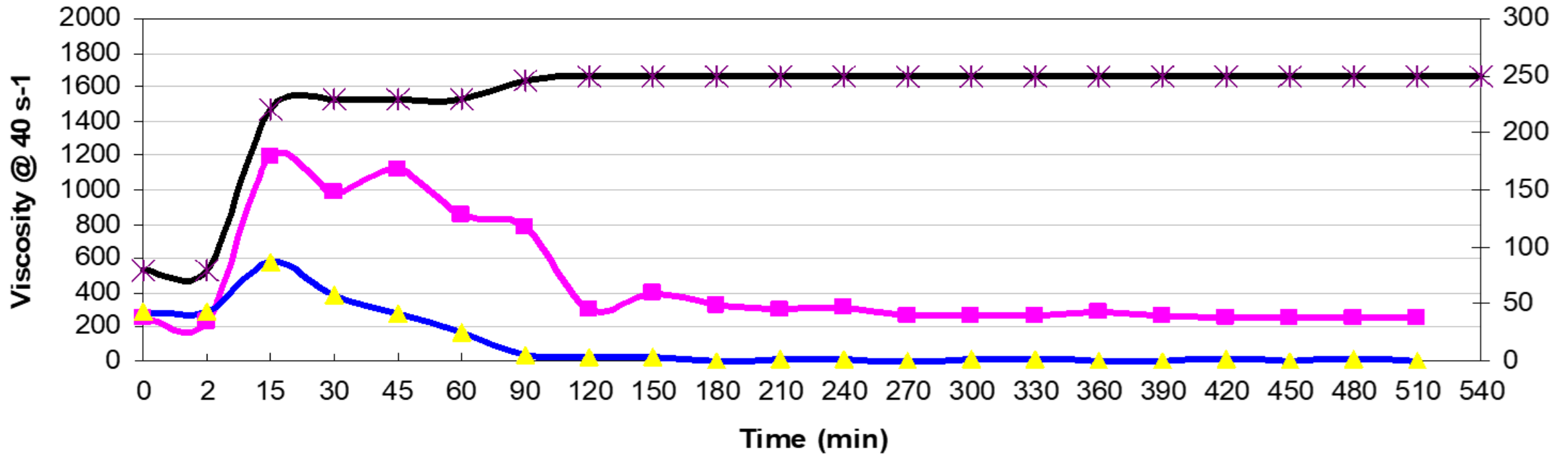
30 ppt Guar @ 180°F
HTHP Viscometer pH 9.64
0.7 gpt Clay Treat 2C, 7.5 gpt GLFC-5D, 0.8 gpt BF-7L, 1 gpt XLW-30, 1 gpt
Hallux Talon Enzyme HT



■ Baseline-no breaker
 ▲ Enzyme HT 1.0 gpt
 ✱ Temp °F



40 ppt Guar @ 230-250°F
HTHP Viscometer pH 9.64
0.7 gpt Clay Treat 2C, 10 gpt GLFC-5D, 0.7 gpt BF-9L, 1 gpt XLW-30, 1 gpt
Hallux Talon Enzyme HT



■ Baseline-no breaker
 ▲ Enzyme HT 1.0 gpt
 ✱ Temp °F



Generic Borate @ 180°F and 250°F, 4000 psi Closure Filter-Cake Only Regain Conductivity Analysis

Liquid Flow Rate after shut-in	0.5-2 ml/min	2 ml/min	2 ml/min	2-10 ml/min	25 ml/min	After Gas flow*
Hours at Closure and Temperature	1 hour	2 hour	5 hour	20 hour	25 hour	50 hours
Breaker Type						
1 gpt Hallux Talon Enzyme HT (180°F)	22.89	18.45	24.06	62.10%	56.10%	95.56%
1 gpt Hallux Talon Enzyme HT (250°F)	16.87	17.84	15.4	12.7	67.3%	80.44%

*Please note that “After Gas Flow” regain conductivity results are always relative, since the objective is to simulate “High Rate Dry” Gas Wells. Polymer is basically dehydrated and only occupies a very small area of the proppant pack pore volume (damage) as compared to “Wet” hydrated polymer in the liquid phase. Therefore, a more accurate effectiveness comparison can be made using the **25 hour liquid flow clean-up regain** numbers.



Generic Borate @ 180°F, 4000 psi Closure Proppant Consortium 2007-2010 Comparison Data

Liquid Flow Rate after shut-in	0.5-2 ml/min	2 ml/min	2 ml/min	2-10 ml/min	25 ml/min	After Gas flow*
Breaker Type @ Closure and Temperature	1 hour	2 hour	5 hour	20 hour	25 hour	50 hours
No breaker	6.7	6.4	7.8	11	17%	
0.1 ppt AP (Ammonium Persulfate)	13.4	12.2	11	9.4	18%	
0.2 ppt AP (Ammonium Persulfate)	4.6	4.6	6.7	7.1	22%	
1 gpt Verenium Enzyme (10%) + 1 ppt Encap AP (200°F) 2013	2.5	9.2	9.9	12.2%	17.9%	54.5%
0.1 ppt AP + 5 ppt Encap AP HP	12	19.1	17	19.3	30%	
1 gpt Hallux Talon Enzyme HT	22.89	18.45	24.06	62.10%	56.10%	95.56%

Generic Borate @ 250°F, 4000 psi Closure Proppant Consortium 2007-2010 Comparison Data

Liquid Flow Rate after shut-in	0.5-2 ml/min	2 ml/min	2 ml/min	2-10 ml/min	25 ml/min	After Gas flow*
At Closure and Temp	1 hour	2 hour	5 hour	20 hour	25 hour	50 hours
Breaker Type						
No breaker	4.1	3.2	4.3	17.7	31%	
no breaker (repeat test)	8.5	11.5	7.1	6.2	23%	
0.1 ppt AP + 1 ppt Encap AP HP	3	1.8	1.6	5.3	15%	
2 ppt Encap AP HP	3.6	4	6	10.6	12%	
4 gpt Magnesium Peroxide	1.4	1.2	1.7	5.1	8%	
4 gpt Magnesium Peroxide (diesel)	1.4	1.4	1.9	4.1	6%	
1 gpt Calcium Peroxide	1.6	1.4	1.2	3	12%	
2 gpt Calcium Peroxide	3.1	3.2	4.1	9.2	15%	
1 gpt Verenium Enzyme (10%) + 1 ppt Encap AP (200°F) 2013	2.5	9.2	9.9	12.2	17.9%	54.5%
5 ppt Vicon HT @ \$14.00/Lbs?	1.1	1.4	1.4	2.3	16%	
5 ppt Vicon HT (repeat test)	1.1	1.4	1.4	2.3	15%	
10 ppt Vicon HT**	1.2	0.9	3.2	7.3	31%	
1 gpt Hallux Talon Enzyme HT	16.87	17.84	15.4	12.7	67.3%	80.44%

**Generic Borate @ 250°F, 4000 psi Closure
Proppant Consortium 2007-2010 Comparison Data**

**10 ppt of Vicon HT is an amount that is actually not “pumpable”, since it basically has no viscosity (<20 cps @ 40s-1) left within 16 minutes at a Temperature of 230°F.

Polymeric Damage

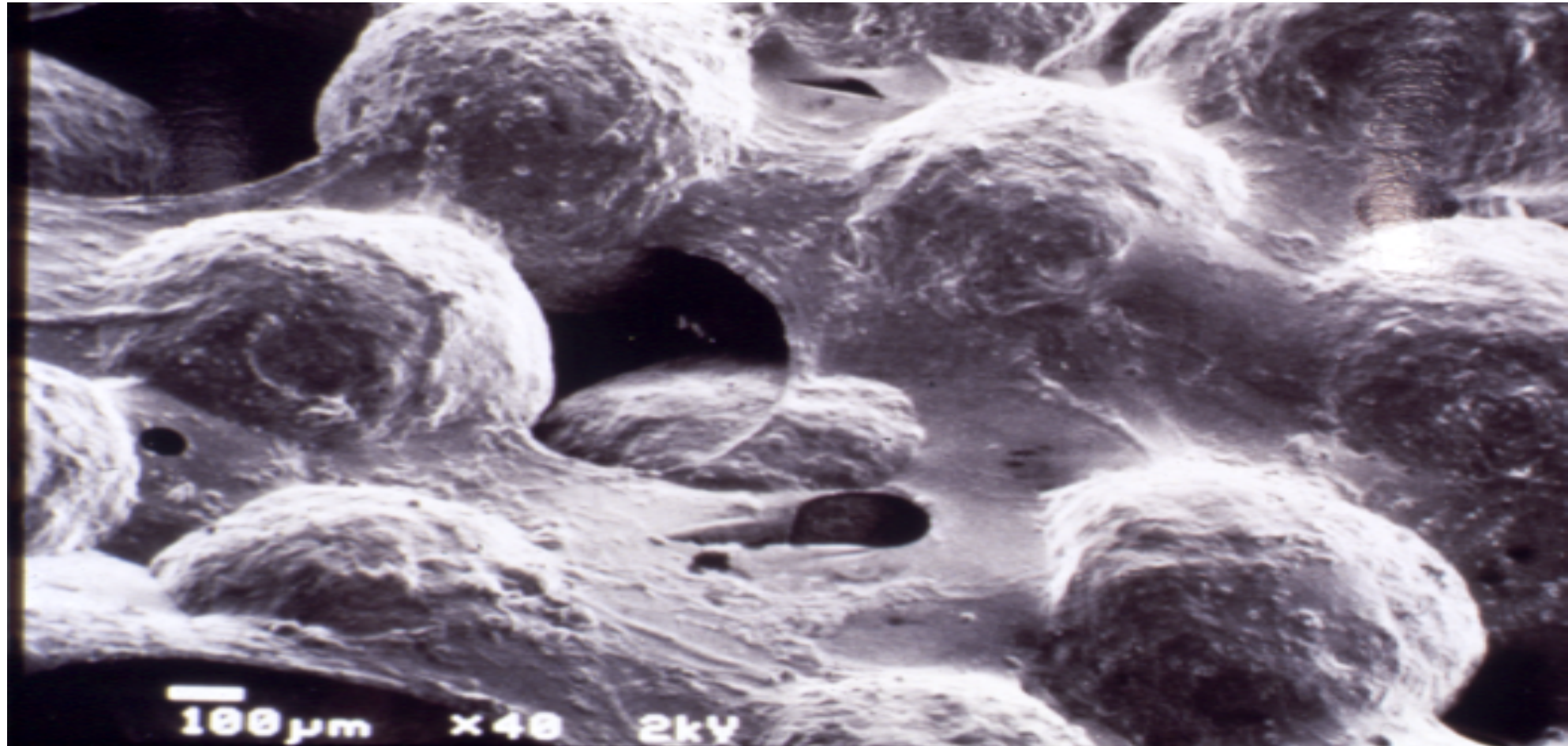
- ◆ Unbroken Gel Residue
- ◆ Dynamically Formed Filter Cake

Occurrence of Polymeric Damage

- ◆ WELL STIMULATION : Guar, Cellulose, Starch and Xanthan
- ◆ WORKOVER OPERATIONS : Cellulose and Starch
- ◆ DRILLING OPERATIONS : Xanthan, Cellulose and/or Starch

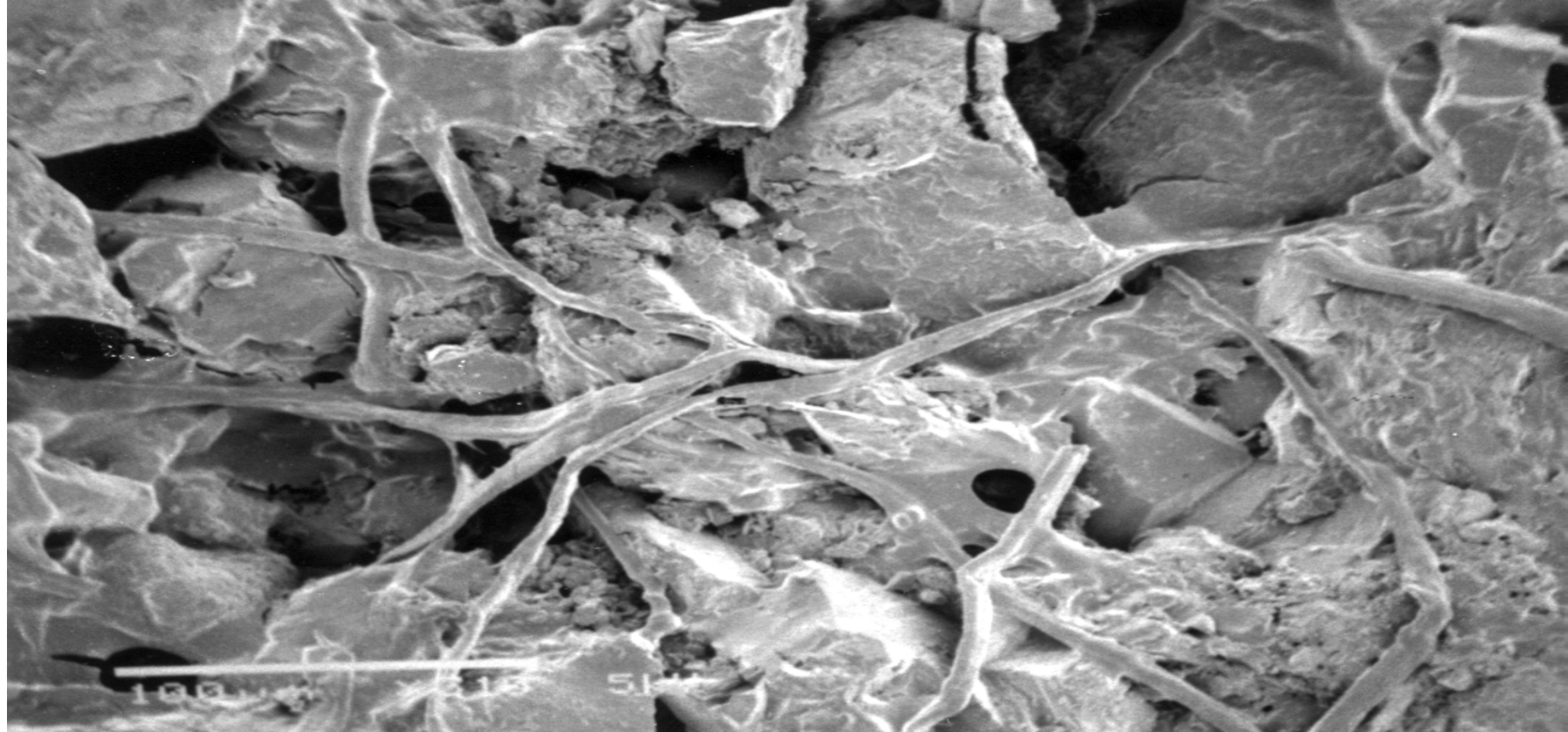
Polymeric Damage

Zr-Ti/ Guar Polymer



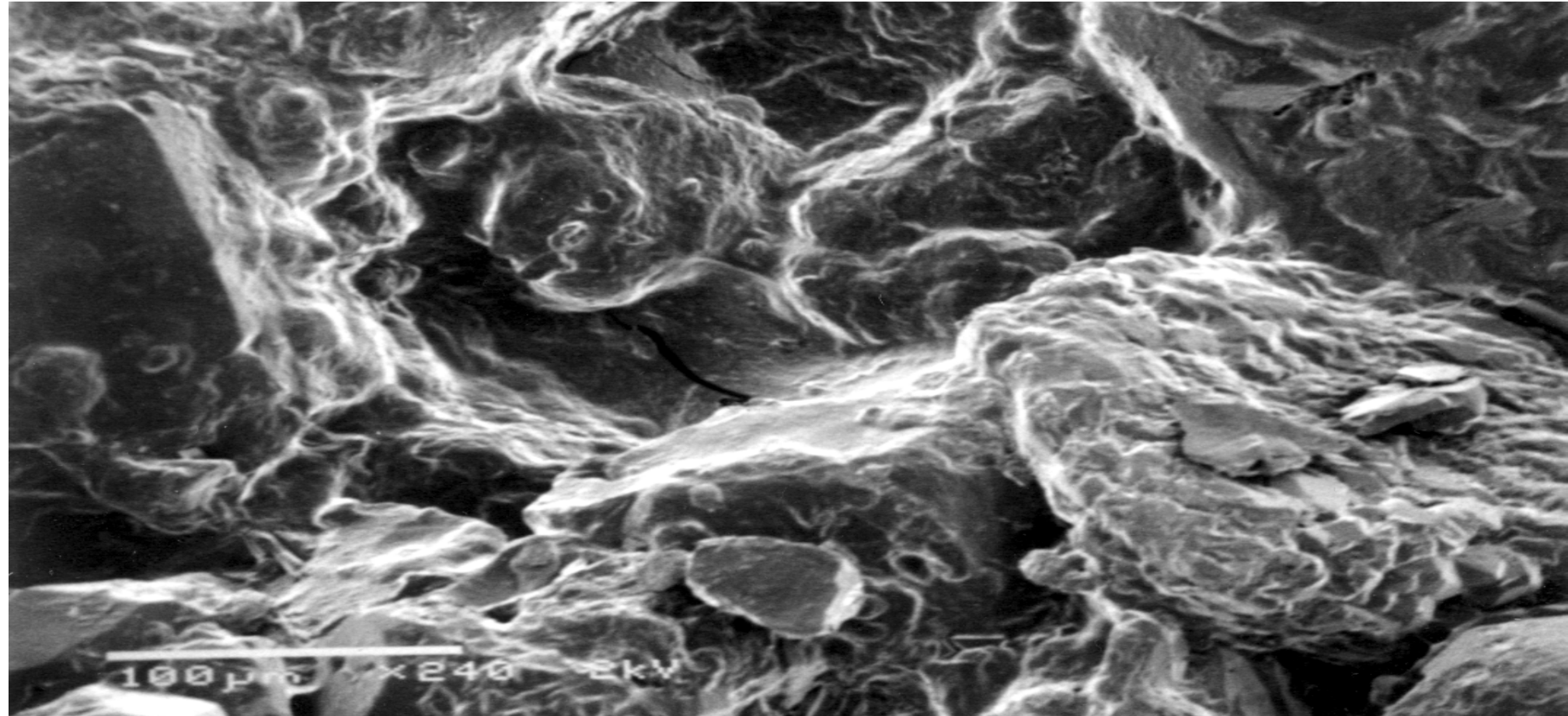
Polymeric Damage

Cellulose Polymer



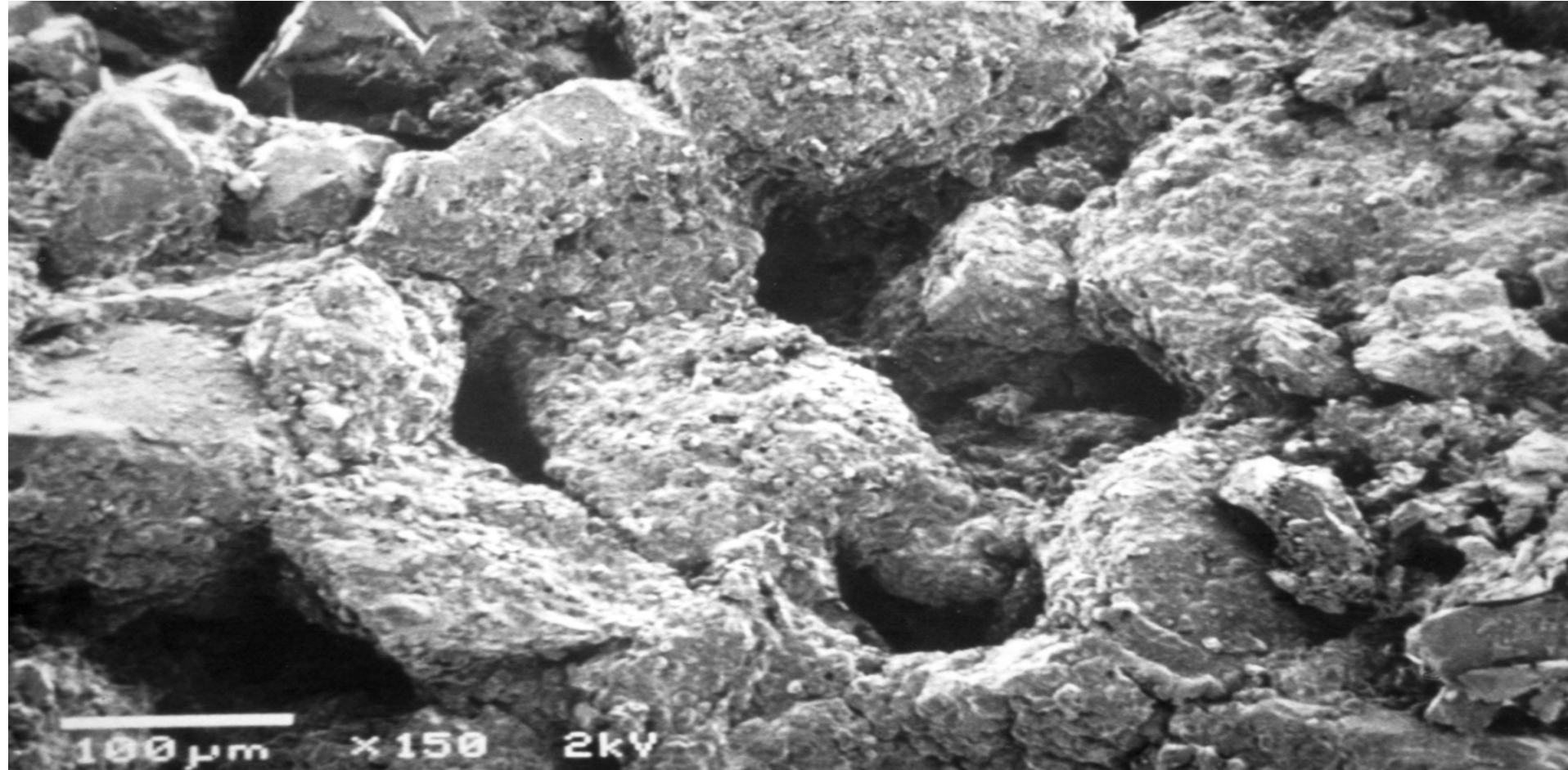
Polymeric Damage

Starch Polymer



Polymeric Damage

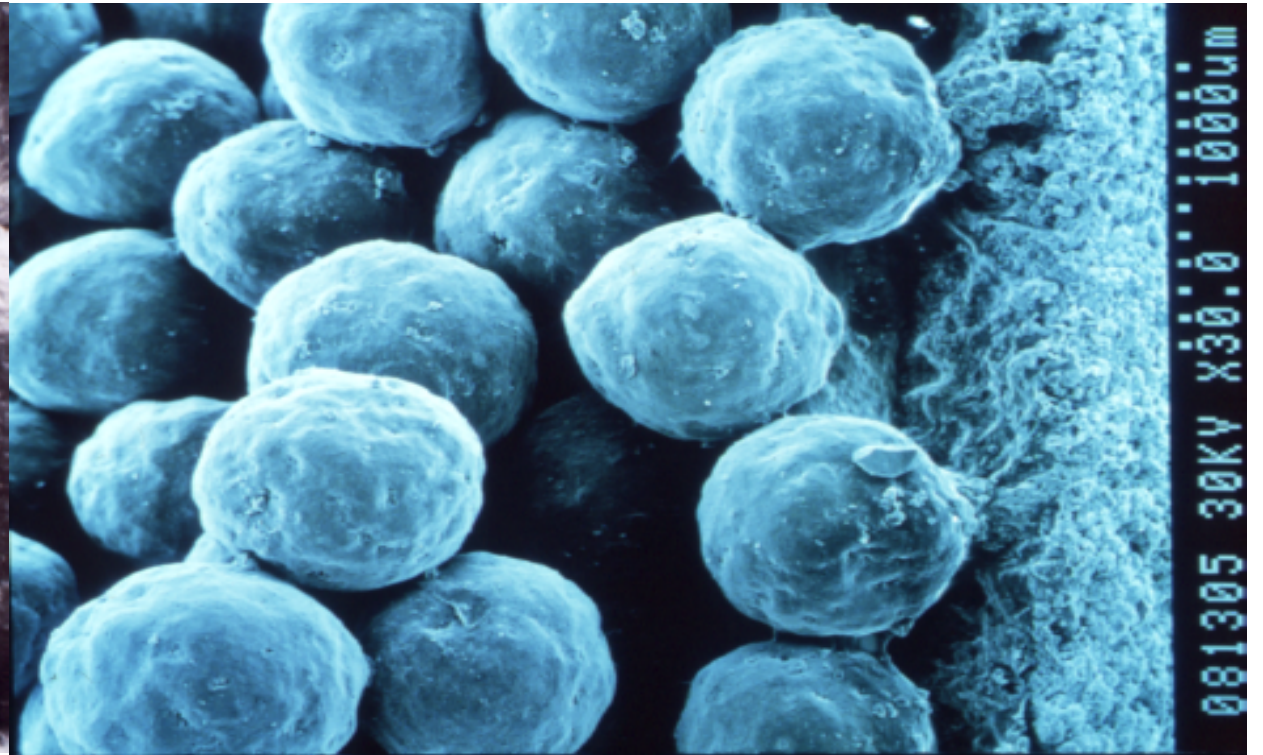
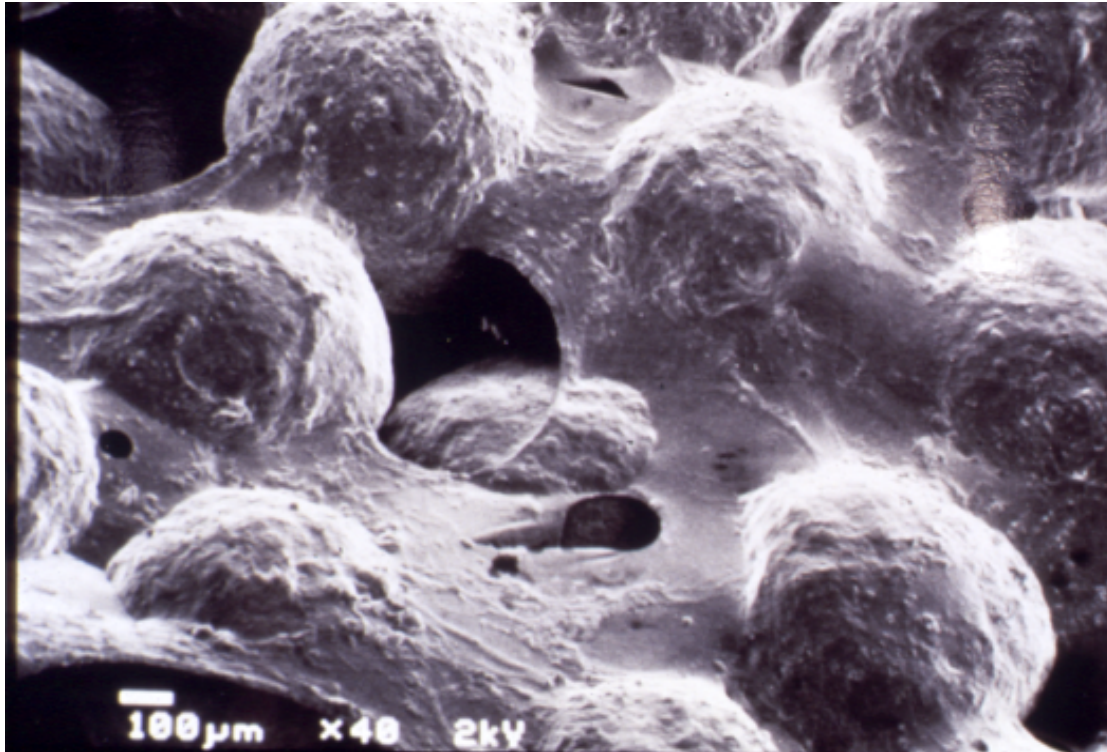
Xanthan Polymer



Polymeric Damage

250°F CMHPG ZrTi

Encapsulated Oxidizer vs Hallux Talon Enzyme

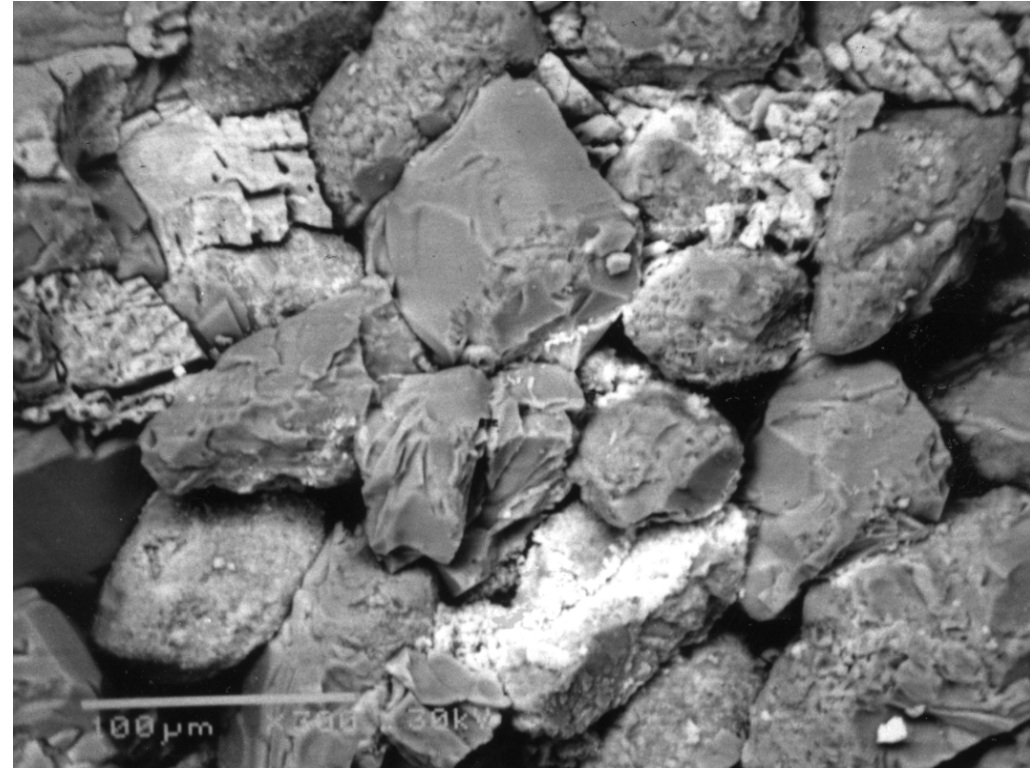
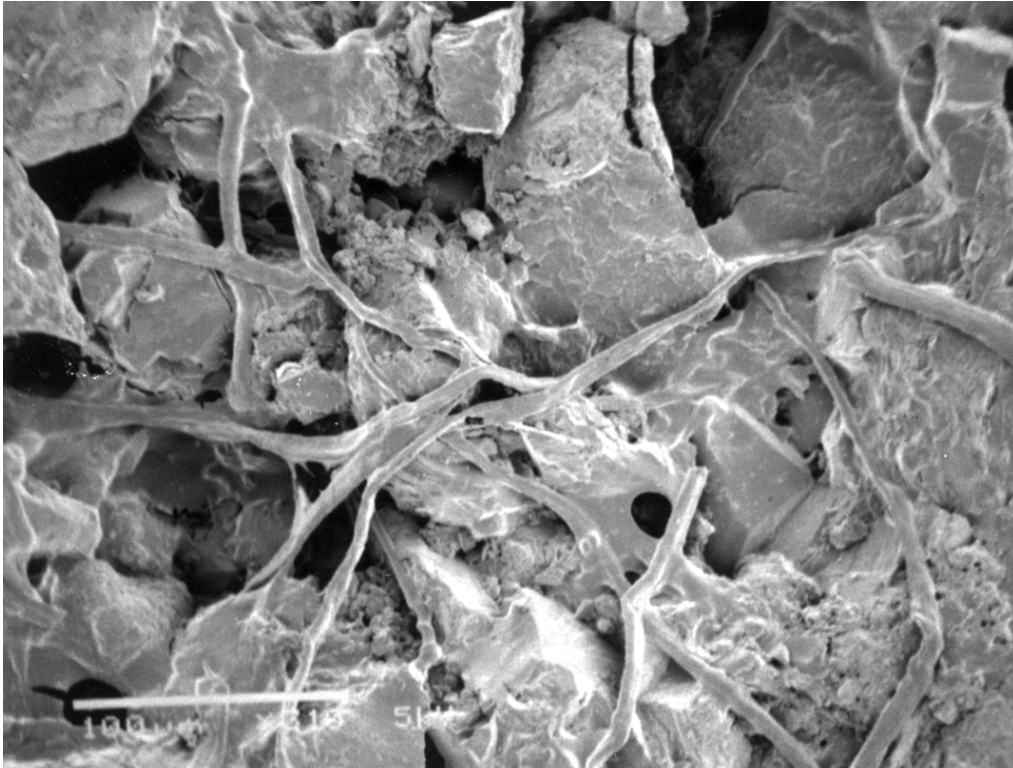


Hallux Talon Cellulases

- ◆ Cellulose Specific Enzyme Breaker
- ◆ Provides for long-term clean-up
- ◆ pH from 3 to 8
- ◆ Temperature range 70°-150°F & 140°-250°F
- ◆ Used in cellulose-based fracs, remedial treatments and drill-in fluid clean-up

Sandstone Core

Before and After Cellulase Degradation

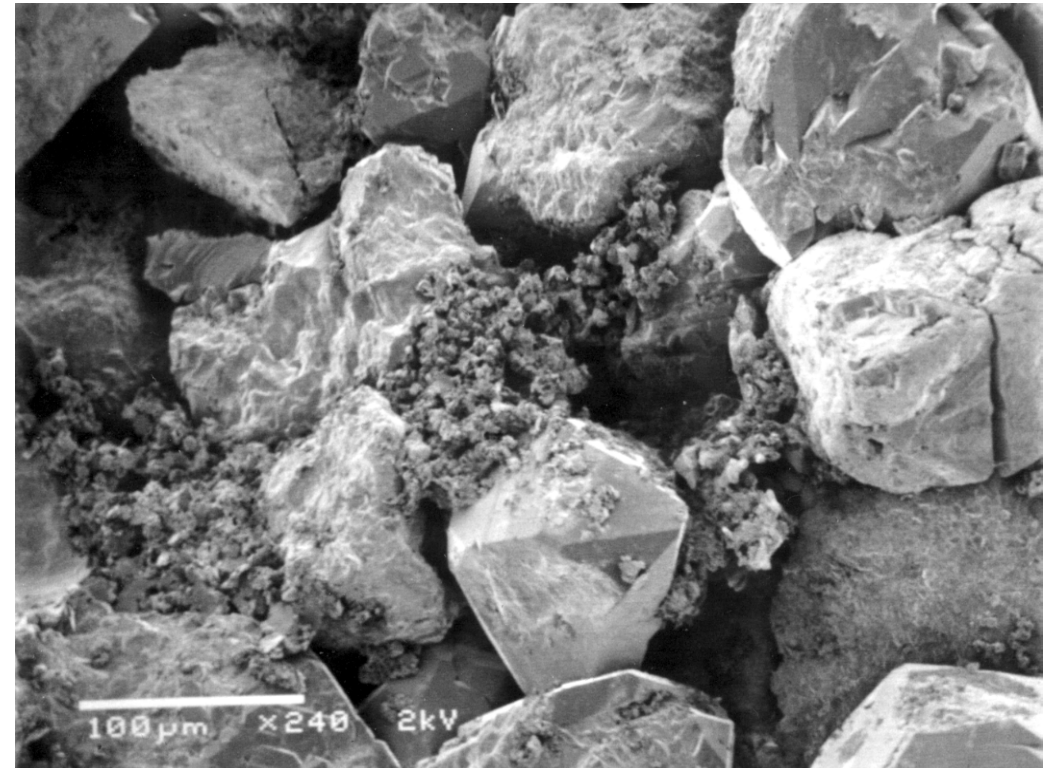
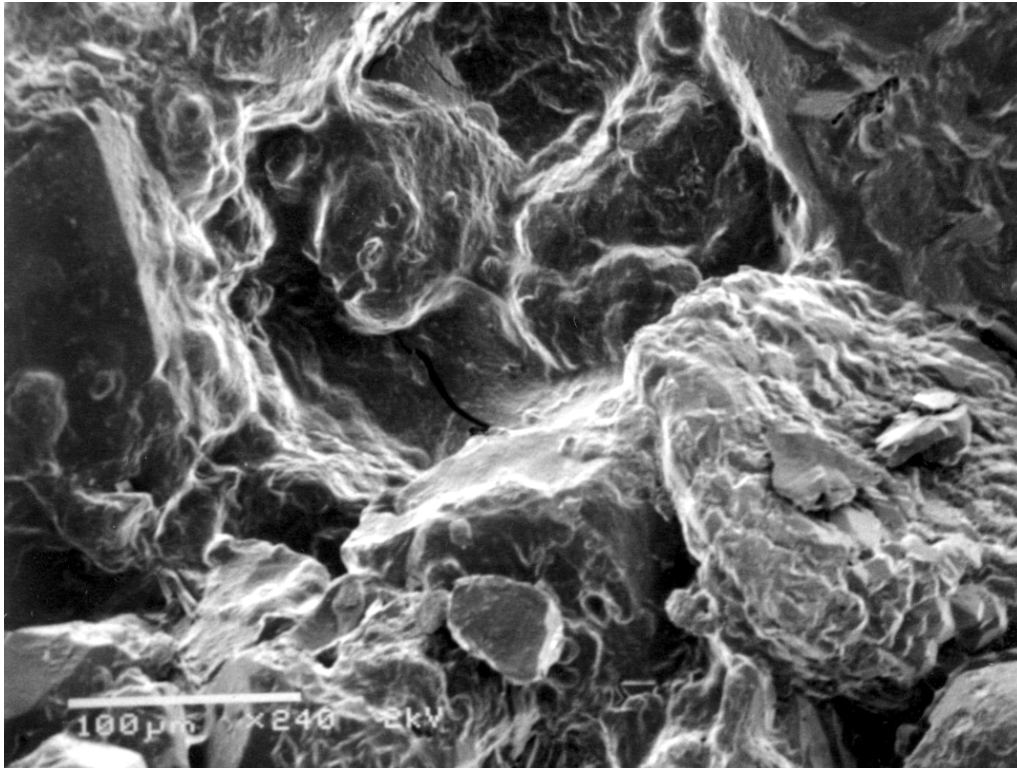


Starch Enzymes (Amylases)

- ◆ Starch specific enzyme breaker
- ◆ Provides for long-term clean-up
- ◆ pH from 3 to 11
- ◆ Temperature range 70° to 275°F
- ◆ Used in crosslinked starch frac fluids and drilling mud removal system

Sandstone Core

Before and After Starch Removal



Hallux Talon Xanthanase

- ◆ Xanthan specific enzyme breaker
- ◆ Provides for long-term clean-up
- ◆ pH from 4 to 8
- ◆ Temperature range 130° to 275°F
- ◆ Used in xanthan based frac fluids and drilling mud removal system

Sandstone Core

Before and After Xanthan Removal

