

The UTEP and ENAM Combined Explosives Tests

Theory

It is common knowledge to most seismologists that using higher velocity explosives produces higher amplitude seismic waves. There is also the well-known relationship that amplitude is proportional to the square root of charge weight. We taken these ideas a step further and have a derived a simple expression relating the seismic strength of a shot, S , to the parameters of the explosive and the configuration of those explosives. S is proportional to seismic amplitude. This relationship is independent of many of the other factors controlling seismic amplitude, such as coupling, attenuation, scattering and geometric spreading. The relationship is

$$S = P_0 W / \rho \sqrt{l}$$

where P_0 is the initial pressure in the borehole, W is the charge weight, ρ is the explosive density and l is the charge length.

Objectives of the UTEP Explosives Test

1. To further test the above relationship over a wider range of explosives than in two previous tests.
2. While most conventional explosives appear to follow the above relationship, aluminized explosives seem to generate much higher detonation pressures than current theory would indicate. We want to find an effective detonation pressure for aluminized explosives as measured from seismic amplitudes.
3. To test an engineering design to substitute aluminized pentolite for ten times the amount of high velocity emulsion, while still producing the same seismic amplitudes. This is applicable to crustal seismic shots.

Experimental Design of the UTEP Explosives Test

To avoid differences in coupling, attenuation and scattering we want to shoot the entire experiment in a square 200 ft. on a side in area where the geology is nearly flat lying and laterally homogeneous. Figure 1 shows the layout of the shotholes for the combined UTEP/ENAM experiment (UTEP hole are 10-24). Recording was done with RT-125A recorders (Texans) with 24-bit of sampling 4.5 Hz geophones at 500 Hz (2 ms). Table 1 contains the coordinates and specific information for each hole.

Objectives of the ENAM Explosives Test

1. To optimize the choice of explosives for the ENAM-CSE (Eastern North American Margin-Community Seismic Experiment).
2. Once an optimal explosive was chosen, engineer a method to economically place this explosive in the subsurface. Figure 2 shows the crustal scale seismic cartridge that was developed next to an industrial scale seismic cartridge.

Experimental Design of the ENAM Explosives Test

As with the UTEP explosives test, the area chosen adjacent to the UTEP test has nearly flat lying, laterally homogeneous geology. Figure 1 also shows the layout of the ENAM shotholes (holes 1-9). Recording is done with the same array of RT-125A recorders, which extended from the source to a distance of 5 km and another array at Pn distance. Table 1 contains the coordinates and specific information for each hole.

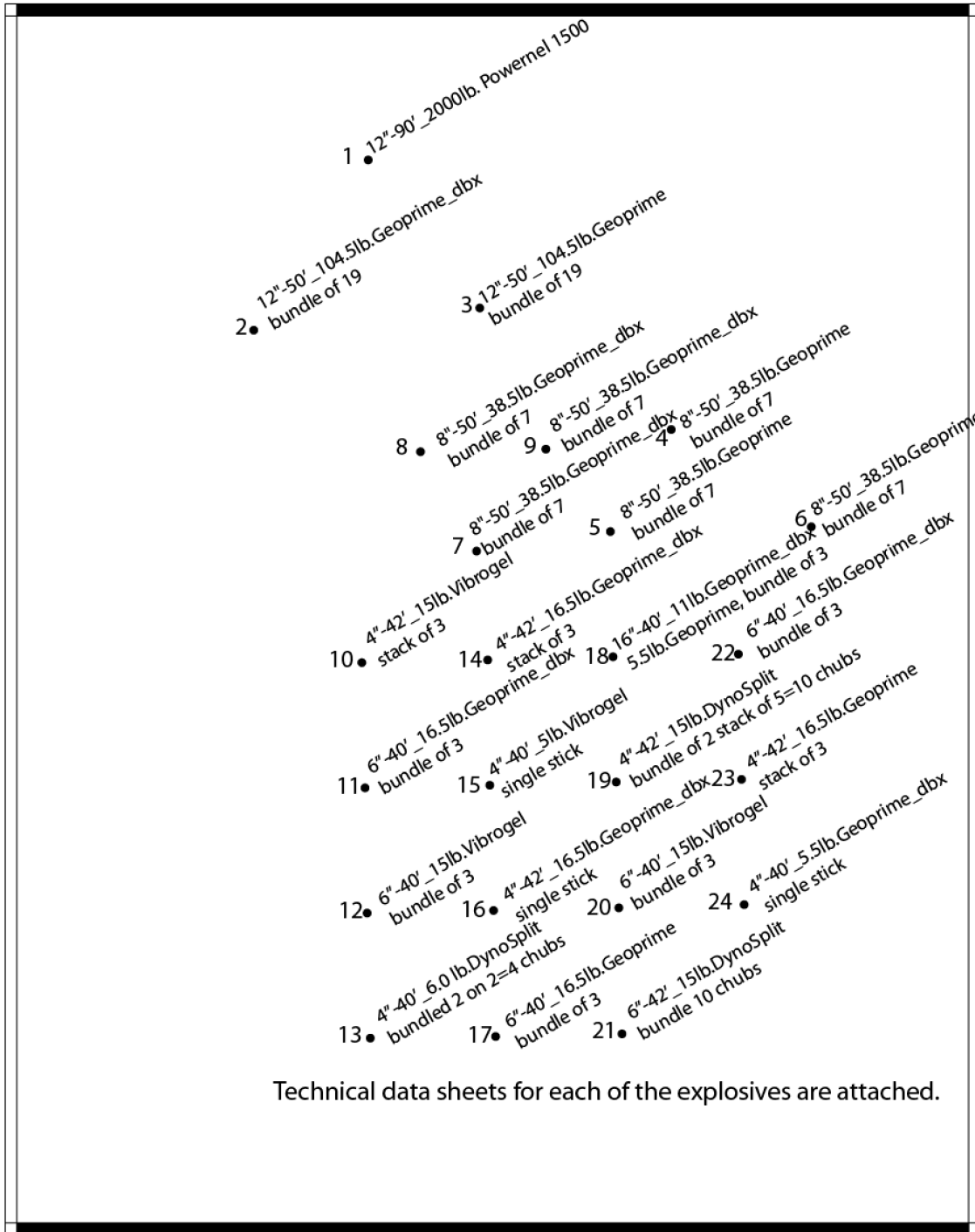


Figure 1. Layout of the UTEP and ENAM Combined Explosives Test. Shotholes (10-24) were loaded with various explosives, including emulsion, seismic gelatin, pentolite and aluminized pentolite, this was the UTEP portion of the test. Large shotholes are for crustal scale shots (1-9) were loaded with various amounts of pentolite, aluminized pentolite, and high velocity bulk emulsion. This was the the ENAM part of the test. Each shotpoint is labelled with the amount and type of explosive contained.



Figure 2. Industry size seismic cartridge on left. Crustal scale seismic cartridge on right. Crustal scale cartridge holds 200 lb. of emulsion at 1.25 g/cc.

Table 1. Coordinates and specifications of shots.

Shot Point/ year	JD	HR	MM	ss	sss	Latitude	UTM Northing (m)	Longitude (m)	UTM Easting (m)	Elev. (m)	Charge WT. (m, LBS.)	BM1 (m)	BM2 (ft)	BM3 (m)	Charge Type, configuration and Size	TOC (ft - bgs)	Charge Len. (ft)				
SP1	2013	321	9	13	0.000	31.82954113	3524041.768	-107.3952457	273309.162	1208.40	2000	155.57	510.41	296.02	971.20	442.06	1450.33	2000 lb. Powernel 1500	53	38	
SP2	2013	321	8	32	0.000	31.82935737	3524021.692	-107.3953893	273295.113	1208.30	104.5	133.36	437.53	277.36	909.96	424.93	1394.13	104.5 lb. Geoprime_dbx, Bdl 19	50.5	2.15	
SP3	2013	321	8	25	0.000	31.82938181	3524023.806	-107.3951104	273322.183	1208.50	104.5	158.63	520.45	304.23	998.14	452.03	1483.03	104.5 lb. Geoprime, Bdl 19	50.5	2.15	
SP4	2013	321	8	7	0.000	31.8292506	3524008.753	-107.3948628	273344.696	1208.45	38.5	174.58	572.77	323.62	1061.76	472.58	1550.45	38.5 lb. Geoprime, Bdl 7	50	2.15	
SP5	2013	321	8	1	0.000	31.829145063	3523996.719	-107.394939	273337.211	1208.36	38.5	164.26	538.91	314.57	1032.05	464.05	1522.48	38.5 lb. Geoprime, Bdl 7	56	2.15	
SP6	2013	321	8	13	0.000	31.82914584	3523996.768	-107.3946862	273361.162	1208.45	38.5	187.67	615.71	338.37	1110.12	487.94	1600.85	38.5 lb. Geoprime, Bdl 7	34	2.15	
SP7	2013	321	7	31	0.000	31.82911985	3523994.769	-107.3951088	273321.091	1208.35	38.5	148.13	485.99	298.33	978.78	447.83	1469.26	38.5 lb. Geoprime_dbx, Bdl 7	55	2.15	
SP8	2013	321	7	37	0.000	31.82922685	3524006.781	-107.3951794	273314.669	1208.36	38.5	145.38	476.96	293.66	963.45	442.51	1451.79	38.5 lb. Geoprime_dbx, Bdl 7	52	2.15	
SP9	2013	321	7	43	0.000	31.82923002	3524006.802	-107.3950212	273329.656	1208.40	38.5	159.62	523.70	308.46	1012.02	457.42	1500.71	38.5 lb. Geoprime_dbx, Bdl 7	54	2.15	
SP10	2013	321	7	0.000	31.82899978	3523981.758	-107.3952534	273307.102	1208.32	15	131.76	432.27	283.11	928.85	433.07	1420.82	15.0 lb. VibroGel, Stk 3	36	6.45		
SP11	2013	321	6	43	0.000	31.82886467	3523966.767	-107.395249	273307.188	1208.32	16.5	130.12	426.90	282.40	926.52	432.69	1419.60	16.5 lb. Geoprime_dbx, Bdl 3	>40	2.15	
SP12	2013	321	6	19	0.000	31.82872939	3523951.761	-107.3952463	273307.119	1208.30	15	130.05	426.67	282.33	926.28	432.69	1419.58	15.0 lb. VibroGel, Bdl 3	>40	2.15	
SP13	2013	321	6	2	0.000	31.82859488	3523936.838	-107.3952421	273307.188	1208.29	6.1	131.82	432.47	283.19	929.09	433.33	1421.70	6.0 lb. DynoSplit, Bdl 2 Stk2 = 4	37	2.67	
SP14	2013	321	7	13	0.000	31.82900275	3523981.755	-107.3950945	273322.156	1208.32	16.5	146.61	481.00	298.12	978.09	448.10	1470.15	16.5 lb. Geoprime_dbx, Stk 3	40	6.45	
SP15	2013	321	6	49	0.000	31.82866759	3523966.76	-107.3950980	273322.176	1208.33	5	145.09	476.00	297.38	975.67	447.68	1468.77	5.0 lb. VibroGel	37.5	2.15	
SP16	2013	321	6	24	0.000	31.82873252	3523951.777	-107.3950874	273322.17	1208.32	5.5	145.08	475.97	297.38	975.64	447.74	1468.95	5.5 lb. Geoprime	24	2.15	
SP17	2013	321	6	8	0.000	31.8285969	3523936.732	-107.3950842	273322.138	1208.29	16.5	146.59	480.94	298.10	978.02	448.27	1470.70	16.5 lb. Geoprime, Bdl3	42	2.15	
SP18	2013	321	7	19	0.000	31.82900597	3523981.781	-107.3949359	273337.178	1208.34	16.5	161.47	529.77	313.11	1027.25	463.11	1519.39	16.5 lb., 2 Geoprime, 1 Geoprime_dbx, Bdl 3	>40	2.15	
SP19	2013	321	6	54	0.000	31.82887058	3523966.761	-107.3949324	273337.182	1208.33	15.25	160.07	525.17	312.39	1024.89	462.69	1518.00	15.0 lb. DynoSplit, Bdl2 Stk 5 = 10	37	6.67	
SP20	2013	321	6	29	0.000	31.8287355	3523951.777	-107.3949293	273337.143	1208.34	15	160.03	525.04	312.34	1024.75	462.71	1518.06	15.0 lb. VibroGel, Bdl 3	38.5	2.15	
SP21	2013	321	6	13	0.000	31.82859666	3523936.705	-107.3949251	273337.209	1208.32	15.25	161.50	529.86	313.13	1027.34	463.32	1520.07	15.0 lb. DynoSplit, Bdl 10	38	1.33	
SP22	2013	321	7	25	0.000	31.82900889	3523981.774	-107.394778	273352.136	1208.44	16.5	176.30	578.40	328.03	1076.20	478.05	1568.42	16.5 lb. Geoprime_dbx, Bdl 3	>32	2.15	
SP23	2013	321	6	59	0.000	31.82887345	3523966.749	-107.3947741	273352.168	1208.41	16.5	175.04	574.29	327.37	1074.04	477.67	1567.16	16.5 lb. Geoprime, Stk 3	36.5	6.45	
SP24	2013	321	6	35	0.000	31.82877092	3523959.233	-107.3947713	273352.108	1208.37	5.5	174.98	574.09	327.31	1073.84	477.67	1567.15	5.5 lb. Geoprime	38	2.15	
BM1						31.82877038	3523959.233	-107.3966188	273177.286	1208.59											
BM2						31.82874038	3523959.233	-107.3982279	273024.887	1209.13											
BM3						31.82872715	3523961.064	-107.3998158	272874.531	1208.94											

Model no.	Blast Mate	s/n	Mic	software version	Calibration Date	Certificate
III	BAL1291	714A9701	714A980BH8655	10.4.0	###	Calibration_data/BM1.pdf
III	BAL17925	714A9701	714A980BH7933	10.4.0	###	Calibration_data/BM2.pdf
III	BAL17896	714A9701	714A980BH7843	10.4.0	###	Calibration_data/BM3.pdf

TECHNICAL INFORMATION

Nelson Brothers, LLC

PowerNel® 1500 Specification

PowerNel 1500 is an ammonium nitrate / hydrocarbon emulsion blasting agent in the form of a water-in-oil emulsion explosive. PowerNel 1500 can be used in packaged or bulk form, and it is often used in combination with low cost ANFO in various proportions to meet individual blasting needs. PowerNel 1500 is sensitized to insure effective performance when used under demanding conditions.

PowerNel® 1500 is manufactured to the following specifications:

PowerNel® 1500	
Parameter	Specification
Density <i>g/cc</i>	1.25 maximum ¹
<i>lb/gal</i>	10.43 maximum ¹
Absolute Weight Strength <i>cal/g</i>	645 ²
Absolute Bulk Strength <i>cal/cc</i>	806
Relative Bulk Strength (% ANFO).....	109
Velocity of Detonation ³ <i>ft/sec</i>	19,000 – 20,000
Shelf Life (minimum, matrix only)	1 year

PowerNel 1500 may be mixed with ammonium nitrate / fuel oil mixtures (ANFO) in any proportion. Blends of PowerNel 1500 with ANFO have been tested to perform according to the following data:

Blend	ANFO	25/75	40/60	50/50	70/30
Density ⁴ <i>g/cc</i>	0.85	1.12	1.34	1.33	1.29
Absolute Strength Value <i>cal/g</i>	886	827	798	773	705
Absolute Bulk Strength <i>cal/cc</i>	753	935	1061	1020	910
Relative Bulk Strength (%ANFO)	100	124	141	135	117
Velocity of Detonation ⁵ <i>ft/sec</i>	12,900	14,000	15,200	16,100	18,700
Water Resistance	None	None	Good	Excellent	Excellent

¹ At normal ambient temperature (approx 75 F)

² From TIGERWIN Program Code, version 4

³ Measured velocities in 6.75 inch diameter borehole, 100% emulsion

⁴ Typical values, may vary with ANFO density

⁵ Typical, averaged values in 6.75 inch borehole

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TROJAN® GEOPRIME® dBX™

Technical
Information



High Performance Pentolite Premium Seismic Energy Source



TROJAN GEOPRIME dBX is a high energy, high performance pentolite seismic explosive researched and engineered to increase elastic waves through improved coupling between the explosive energy and the earth. In a new approach to explosives application in geophysical exploration, TROJAN GEOPRIME dBX offers high detonation velocity and superior low post-detonation gas production. TROJAN GEOPRIME dBX produces improved seismic energy across the usable bandwidth for superior final stack data as well as improved signal-to-noise ratios. In addition, the specialized design of the TROJAN GEOPRIME dBX plastic shell allows charge weight to be varied, as needed, by screwing the shells together. Designed by geophysicists and Dyno Nobel explosives engineers, TROJAN GEOPRIME dBX is the next generation of seismic explosives.

Application Recommendations

- **NEVER** use Dyno Nobel seismic explosive products and/or components with explosive products and/or components made by other manufacturers.
- **ALWAYS** use Dyno Nobel's Electric Super Seismic high strength detonator for optimum results.
- Recommended temperature range is -40° C to 65° C (-40° F to 150° F). TROJAN GEOPRIME dBX is unaffected by extremely low temperatures but detonators produce less energy below -40° C (-40° F).
- **ALWAYS** use built-in cap wells for seismic detonators. Two detonators are recommended to minimize environmental issues with abandoned charges.

USE CAUTION WHEN SLEEP TIME IS ANTICIPATED

A loaded hole that is not shot immediately after the detonator tests positive with a ShotPoint Tracker™ or other testing device could fail for reasons beyond the control of the drill crew and product manufacturer. Reasons for failure could include but are not limited to geologic shifting, lightning, vandalism, farmer or animal interference.

Properties

MSDS
#1145

Energy ^a (cal/g)	1,880
Gas Volume ^a (moles/kg)	20.5
Velocity ^c (m/sec)	7,300
(ft/sec)	23,950
Detonation Pressure ^c (Kbars)	227
Density (g/cc)	1.70
Water Resistance	Excellent

^a All Dyno Nobel Inc. energy and gas volume values are calculated using PRODET™, the computer code developed by Dyno Nobel Inc. for its exclusive use. Other computer codes may give different values.

^c Unconfined 57 mm diameter x 2 kg charge.

IMPORTANT!

Ignoring these warnings may result in injury or death!

- **ALWAYS** exercise extreme caution when approaching a shothole that has not vented. Venting gases after detonation are common. BLOWOUTS CAN INJURE OR KILL.
- **NEVER** attempt to alter the product by cutting, sawing or disassembly of the package.
- **NEVER** drop load explosive into a borehole.
- **NEVER** attempt to dislodge explosives by pushing with a drill stem.
- **NEVER** unshunt electric detonators prior to use except to test with blasting galvanometer.
- **ALWAYS** shunt electric detonators and/or the blast circuit after testing and keep shunted until connected to blasting machine.
- **NEVER** use detonating cord to prime TROJAN GEOPRIME dBX.
- **ALWAYS** ask if you don't know before proceeding.

Hazardous Shipping Description
Boosters, 1.1D, UN 0042



TROJAN® GEOPRIME® dBX™

Technical Information



- **ALWAYS** use two Electric Super Seismic detonators. A broken wire is the primary cause of abandoned seismic charges so protect your investment, increase performance and minimize liability. Require all personnel who handle or come into contact with explosive materials to be fully trained in the proper storage, handling and use of explosive products.
- TROJAN GEOPRIME dBX maximum water depth is limited by the initiation system used.
- **NEVER** use TROJAN GEOPRIME dBX with detonating cord. Misfires may result.

Transportation, Storage and Handling

- TROJAN GEOPRIME dBX must be transported, stored, handled and used in conformity with all applicable federal, state, provincial and local laws and regulations. Stock should be rotated. Use older stock first. For recommended good practices in transporting, storing, handling and using this product, see the booklet "Prevention of Accidents in the Use of Explosive Materials" packed inside each case and the Safety Library Publications of the Institute of Makers of Explosives. As with all high explosives, cool, dry, well ventilated storage is recommended.
- TROJAN GEOPRIME dBX has a substantially unlimited shelf life when stored between -40°C and 38° C (-40° F and 100° F) provided the product has not been submerged in water. Product older than five years old should be inspected by a qualified Dyno Nobel representative prior to use.

Undetonated Explosives

- Dyno Nobel's policy is to provide the highest quality and most reliable explosives

Packaging

TROJAN GEOPRIME dBX is packaged in highly visible plastic cartridges with positive coupling available where increased charge weights are desired.

Dyno Nobel Part Number*	Nominal Unit Size	Package Style	Case Count Units per Case	Gross Case Weight	Case Dimensions	
					Centimeters	Inches
DB0165	36 mm (1.43 in) x .165 kg (0.36 lb)	Paper	95	17.0 kg / 37.4 lb	42 x 33 x 14	16.5 x 13.25 x 5.5
DB0250	41 mm (1.6 in) x .25 kg (0.55 lb)	Paper	72	18.6 kg / 41.0 lb	42 x 33 x 14	16.5 x 13.25 x 5.5
DB0500	57 mm (2.3 in) x 0.5 kg (1.1 lb)	Plastic	30	17.0 kg / 37.4 lb	85.75 x 32.4 x 12.7	33.75 x 12.75 x 5
DB1000	57 mm (2.3 in) x 1.0 kg (2.2 lb)	Plastic	20	21.3 kg / 46.9 lb	85.75 x 32.4 x 12.7	33.75 x 12.75 x 5
DB2000	57 mm (2.3 in) x 2.0 kg (4.4 lb)	Plastic	10	20.8 kg / 45.8 lb	85.75 x 32.4 x 12.7	33.75 x 12.75 x 5
DB2500	57 mm (2.3 in) x 2.5 kg (5.5 lb)	Plastic	10	26.0 kg / 57.0 lb	85.75 x 32.4 x 12.7	33.75 x 12.75 x 5

* For Canadian part numbers, add a "C" at the end (i.e., DB0500C)

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products and initiation systems possible for seismic exploration. To assure our customers of the best commercial explosive products, Dyno Nobel has implemented manufacturing processes and controls. Dyno Nobel recommends the use of two Electric Super Seismic detonators. A broken detonator leg wire is the prime cause of undetonated seismic charges. Protect your investment in seismic exploration by requiring training on the proper use of explosive materials for all who handle, use or have contact with explosive materials.

- The user of this product (or any other explosive product) should not abandon undetonated charges in the ground. Abandoning undetonated charges constitutes misuse of the product for which Dyno Nobel and its subsidiaries are not responsible.

Bioremediation Technology

The Ensign-Bickford Company developed and patented the bioremediation technology which involves casting millions of freeze-dried microorganisms (along with nutrients for those microorganisms) directly into the TROJAN GEOPRIME dBX seismic booster during production. When these naturally occurring organisms are submerged in water, they become activated, as designed, and begin to slowly biotransform the undetonated TROJAN GEOPRIME dBX. When the biotransformation is complete, the compounds are no longer explosive. Complete and continuous submersion in water is required to sustain the bioremediation process. In addition, the process is dependent on various other factors and environmental conditions. For these reasons, Dyno Nobel makes no claim as to the effectiveness of the biotransformation process or the duration of time required to complete it.

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DYNO
Dyno Nobel

Groundbreaking Performance

TROJAN® GEOPRIME®

Technical Information



Bioremediation Technology in Pentolite



Product Description

TROJAN GEOPRIME is a high energy, highly reliable, seismic explosive containing patented bioremediation technology (see back for detailed explanation) and made from the highest quality PETN and other high explosive materials ensuring reliability, consistency and durability. TROJAN EOPRIME provides consistent energy release in all extreme seismic environments regardless of hydrostatic pressure or borehole depths. The specialized design of the Geoprime plastic shell allows charge weight to be varied, as needed, by screwing the shells together.

Application Recommendations

- **NEVER** use Dyno Nobel seismic explosive products and/or components with explosive products and/or components made by other manufacturers.
- **ALWAYS** use the Dyno Nobel Electric Super Seismic high strength detonator for optimum results.
- Recommended temperature range is -40°C to 65°C (-40°F to 150°F). Geoprime is unaffected by extremely low temperatures but detonators produce less energy below -40°C (-40°F).
- **ALWAYS** use built-in cap wells for seismic detonators. Two detonators are recommended for insurance and reliability where extreme environmental conditions or prolonged exposure periods are encountered.
- Maximum water depth is 92 meters (300 feet; 125 psi) for 6 months.
- **NEVER** use GEOPRIME with detonating cord. Misfires may result.

USE CAUTION WHEN SLEEP TIME IS ANTICIPATED

A loaded hole that is not shot immediately after the detonator tests positive with a ShotPoint Tracker™ or other testing device could fail for reasons beyond the control of the drill crew and product manufacturer. Reasons for failure could include but are not limited to geologic shifting, lightning, vandalism, farmer or animal interference.

Properties

MSDS
#1145

Energy ^a (cal/g)	1,500
Gas Volume ^a (moles/kg)	27.9
Velocity ^c (m/sec) (ft/sec)	7,500 24,600
Detonation Pressure ^c (Kbars)	230
Density (g/cc)	1.63
Water Resistance	Excellent

^a All Dyno Nobel Inc. energy and gas volume values are calculated using PRODET™, the computer code developed by Dyno Nobel Inc. for its exclusive use. Other computer codes may give different values.

^c Unconfined 57 mm diameter x 2 kg charge.

IMPORTANT!

Ignoring these warnings may result in injury or death!

- **ALWAYS** exercise extreme caution when approaching a shothole that has not vented. Venting gases after detonation are common. BLOWOUTS CAN INJURE OR KILL.
- **NEVER** attempt to alter the product by cutting, sawing or disassembly of the package.
- **NEVER** drop load explosive into a borehole.
- **NEVER** attempt to dislodge explosives by pushing with a drill stem.
- **NEVER** unshunt electric detonators prior to use except to test with blasting galvanometer.
- **ALWAYS** shunt electric detonators and/or the blast circuit after testing and keep shunted until connected to blasting machine.
- **NEVER** use detonating cord to prime TROJAN GEOPRIME.
- **ALWAYS** ask if you don't know before proceeding.

Hazardous Shipping Description

Boosters, 1.1D, UN 0042 EX-2005120120



TROJAN® GEOPRIME®

Technical Information



Transportation, Storage and Handling

- TROJAN GEOPRIME must be transported, stored, handled and used in conformity with all applicable federal, state, provincial and local laws and regulations. Stock should be rotated. Use older stock first. For recommended good practices in transporting, storing, handling and using this product, see the booklet "Prevention of Accidents in the Use of Explosive Materials" packed inside each case and the Safety Library Publications of the Institute of Makers of Explosives. As with all high explosives, cool, dry, well ventilated storage is recommended.
- TROJAN GEOPRIME has a substantially unlimited shelf life when stored between -40°C and 65° C (-40° F and 150° F) provided the product has not been submerged in water. Product older than five years old should be inspected by a qualified Dyno Nobel representative prior to use.

Undetonated Explosives

- Dyno Nobel's policy is to provide the highest quality and most reliable explosives products and initiation systems possible for seismic exploration. To assure our customers of the best commercial explosive products, Dyno Nobel has implemented manufacturing processes and controls. When difficult drilling conditions are encountered or when rough loading conditions exist, Dyno Nobel recommends the use of two (2) Electric Super Seismic detonators. A broken detonator leg wire is the

prime cause of undetonated seismic charges. Protect your investment in seismic exploration by requiring training on the proper use of explosive materials for all who handle, use or have contact with explosive materials.

- The user of this product (or any other explosive product) should not abandon undetonated charges in the ground. Abandoning undetonated charges constitutes misuse of the product for which Dyno Nobel and its subsidiaries are not responsible.

Bioremediation Technology

The Ensign-Bickford Company developed and patented the bioremediation technology which involves casting millions of freeze-dried microorganisms (along with nutrients for those microorganisms) directly into the TROJAN GEOPRIME seismic booster during production. When these naturally occurring organisms are submerged in water, they become activated, as designed, and begin to slowly biotransform the undetonated TROJAN GEOPRIME. When the biotransformation is complete, the compounds are no longer explosive. Complete and continuous submersion in water is required to sustain the bioremediation process. In addition, the process is dependent on various other factors and environmental conditions. For these reasons, Dyno Nobel makes no claim as to the effectiveness of the biotransformation process or the duration of time required to complete it.

Packaging

TROJAN GEOPRIME is packaged in highly visible plastic cartridges with positive coupling available where increased charge weights are desired.

Dyno Nobel Part Number*	Nominal Unit Size	Package Style	Case Count Units per Case	Case Dimensions Centimeters			Case Dimensions Inches		
GE0500	57 mm (2.25 in) x 0.5 kg (1.1 lb)	Plastic	30	85.75	32.4	12.7	33 ¾	12 ¾	5
GE1000	57 mm (2.25 in) x 1.0 kg (2.2 lb)	Plastic	20	85.75	32.4	12.7	33 ¾	12 ¾	5
GE2000	57 mm (2.25 in) x 2.0 kg (4.4 lb)	Plastic	10	85.75	32.4	12.7	33 ¾	12 ¾	5
GE2500	57 mm (2.25 in) x 2.5 kg (5.5 lb)	Plastic	10	85.75	32.4	12.7	33 ¾	12 ¾	5

* For Canadian part numbers, add a "C" at the end (i.e., GE0500C)

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DYNO
Dyno Nobel

Groundbreaking Performance™

VIBROGEL®

Technical Information



Seismic Extra Gelatin Nitroglycerin Dynamite



Product Description

VIBROGEL is a high density, high velocity, high energy gelatin dynamite available in either a plastic or paper tube shell that has been in use in the geophysical industry for more than 80 years. VIBROGEL produces a sharp pulse of seismic energy and detonates completely at high velocity.

USE CAUTION WHEN SLEEP TIME IS ANTICIPATED

A loaded hole that is not shot immediately after the detonator tests positive with a ShotPoint Tracker™ or other testing device could fail for reasons beyond the control of the drill crew and product manufacturer. Reasons for failure could include but are not limited to geologic shifting, lightning, vandalism, farmer or animal interference.

Application Recommendations

- **NEVER** use Dyno Nobel seismic explosive products and/or components with explosive products and/or components made by other manufacturers.
- **ALWAYS** use the Dyno Nobel Electric Super Seismic high strength detonator for optimum results.
- Recommended temperature range is 40°C to 65°C (-40°F to 150°F). VIBROGEL is unaffected by extremely low temperatures but detonators produce less energy below -40°C (-40°F).
- VIBROGEL is not recommended for extended wet hole use / sleep time. Please contact your Dyno Nobel Representative for additional details.

Properties

MSDS
#1019

Energy ^a (cal/g)	1,250
Gas Volume ^a (moles/kg)	26
Velocity ^b (m/sec)	6,100
(ft/sec)	20,000
Detonation Pressure ^b (Kbars)	133
Density (g/cc)	1.43
Water Resistance	Limited

^a All Dyno Nobel Inc. energy and gas volume values are calculated using PRODET™, the computer code developed by Dyno Nobel Inc. for its exclusive use. Other computer codes may give different values.

^b Unconfined 57 mm diameter x 2 kg charge.

IMPORTANT!

Ignoring these warnings may result in injury or death!

- **ALWAYS** exercise extreme caution when approaching a shothole that has not vented. Venting gases after detonation are common. BLOWOUTS CAN INJURE OR KILL.
- **NEVER** attempt to alter the product by cutting, sawing or disassembly of the package.
- **NEVER** drop load explosive into a borehole.
- **NEVER** attempt to dislodge explosives by pushing with a drill stem.
- **ALWAYS** shunt electric detonators and/or the blast circuit after testing and keep shunted until connected to blasting machine.
- **NEVER** unshunt electric detonators prior to use except to test with blasting galvanometer.
- **ALWAYS** ask if you don't know before proceeding.

Hazardous Shipping Description

Explosive, Blasting, Type A 1.1D UN 0081 II





- For optimum results, the seismic detonator should always be placed in the capwell and interlocked between charges or between the charge and the anchoring device. Two detonators are recommended for insurance and reliability where extreme environmental conditions are encountered.
- When using paper tube shells or whenever the plastic shells are used as single unit charges and without an anchoring device or protective loading device, it is recommended that the charge be side primed at a point about half the cartridge length. To side prime, use an approved powder punch and punch on a downward angle (not across cartridge). Care should be taken to insert the seismic detonator so that the base of the detonator comes to rest nearest the center of the charge diameter (not against the shell wall) and so that only the detonator leg wires are exposed. Always double half-hitch the leg wires to secure the detonator to the charge.

Transportation, Storage and Handling

- The user of this product (or any other explosive product) should not leave or abandon undetonated charges in the ground. The leaving or abandoning of undetonated charges constitutes misuse of the product for which Dyno Nobel and its distributors are not responsible.
- VIBROGEL must be transported, stored, handled and used in conformity with all applicable federal, state, provincial and local laws and regulations.
- For maximum shelf-life, VIBROGEL must be stored in cool, dry and well-ventilated magazines. If stored properly, VIBROGEL has a shelf life of 12 months from date of manufacture. Dynamite that is stored under warm wet and/or humid conditions can deteriorate quickly, minimizing shelf-life. Dynamite inventory should always be rotated by using the oldest materials first. For recommended good practices in transporting, storing, handling and using this product, see the booklet "Prevention of Accidents in the Use of Explosive Materials" packed inside each case and the Safety Library publications of the Institute of Makers of Explosives.

Packaging

Diameter mm (in)	Cartridge Weight kg (lb)	Cartridge Type	Cartridges per Case	Case Weight kg (lbs)	Case Dimensions Centimeters	Case Dimensions Inches
27 mm (1.00 in)	0.125 kg (0.25 lb)	Tube Shell	160	20 kg (44 lbs)	43 x 35 x 22	17 $\frac{1}{8}$ x 13 $\frac{3}{8}$ x 7 $\frac{1}{4}$
50 mm (2.00 in)	0.25 kg (0.50 lb)	Tube Shell-T ^a	80	20 kg (44 lbs)	39 x 32 x 22	15 $\frac{1}{4}$ x 12 $\frac{1}{2}$ x 8 $\frac{3}{4}$
50 mm (2.00 in)	0.50 kg (1.10 lb)	Tube Shell-T ^a	40	20 kg (44 lbs)	40 x 32 x 20	15 $\frac{1}{4}$ x 12 $\frac{1}{2}$ x 7 $\frac{7}{8}$
50 mm (2.00 in)	1.0 kg (2.20 lb)	Tube Shell-T ^a	20	20 kg (44 lbs)	39 x 32 x 22	15 $\frac{1}{4}$ x 12 $\frac{1}{2}$ x 8 $\frac{3}{4}$
50 mm (2.00 in)	1.5 kg (3.30 lb)	Tube Shell-T ^a	12	18 kg (40 lbs)	58 x 39 x 12	23 x 15 x 4 $\frac{3}{4}$
50 mm (2.00 in)	2.0 kg (4.40 lb)	Tube Shell	10	20 kg (44 lbs)	43 x 35 x 18	17 $\frac{1}{8}$ x 13 $\frac{5}{8}$ x 7 $\frac{1}{4}$
60 mm (2.36 in)	1.0 kg (2.20 lb)	Plastic Shell	20	20 kg (44 lbs)	43 x 35 x 18	17 $\frac{1}{8}$ x 12 $\frac{5}{8}$ x 7 $\frac{1}{4}$
60 mm (2.36 in)	2.0 kg (4.40 lb)	Plastic Shell	10	20 kg (44 lbs)	72 x 30 x 12	28 $\frac{1}{4}$ x 11 $\frac{1}{8}$ x 4 $\frac{3}{4}$
All metric sizes are non-standard		^a Twine Shells				

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DYNOSPLIT® ARCTIC

Technical
Information



Small Diameter Detonator Sensitive Continuous Packaged Emulsion



Product Description

DYNOSPLIT ARCTIC is a detonator sensitive, perchlorate free, packaged emulsion explosive product produced in a continuous cartridge form specifically for presplitting applications in extremely cold climates. DYNOSPLIT ARCTIC is crimped every 400 mm (16 in) and externally traced the entire length with 17 g/m (80 gr/ft) detonating cord and high tensile strength twine. The decoupled continuous explosive column provides consistent borehole pressure along the entire loaded borehole zone during detonation, resulting in a uniform tensile shearing effect. DYNOSPLIT ARCTIC can be cut to fit the desired load length or spliced to increase the load length.

Application Recommendations

- DYNOSPLIT ARCTIC is recommended for use with a high strength electric, electronic or nonelectric detonator or the appropriate core load detonating cord.
- When initiating with a detonator, **ALWAYS** attach the detonator directly to the external trace detonating cord on the DYNOSPLIT ARCTIC packaged emulsion.
- When initiating with detonating cord, **ALWAYS** use 5.3 g/m (25 gr/ft) detonating cord or higher and connect directly to the external trace detonating cord with a square (reef) knot.
- DYNOSPLIT ARCTIC will perform in temperatures as low as -40°C (-40°F). If temperatures are lower than -40°C (-40°F), **ALWAYS** allow DYNOSPLIT ARCTIC to warm up to at least -40°C (-40°F) after loading boreholes and before initiation.

Properties

MSDS
#1157

Density (g/cc) Avg	1.15
Energy ^a (cal/g) (cal/cc)	1,000 1,161
Relative Weight Strength ^{a,b}	1.14
Relative Bulk Strength ^{a,b}	1.61
Velocity ^b (m/s) (ft/s)	5,900 19,350
Detonation Pressure ^b (kbars)	100
Gas Volume ^a (moles/kg)	38
Weight / Length (kg/m) (lbs/ft)	1.58 1.07
Water Resistance	Excellent

a All Dyno Nobel Inc. energy and gas volume values are calculated using PRODET™, the computer code developed by Dyno Nobel Inc. for its exclusive use. Other computer codes may give different values.

b Unconfined @ 57 mm (2¼ in) diameter; emulsion only. Actual VOD of DYNOSPLIT ARCTIC is dependent on VOD of detonating cord = ~6,800 m/sec (22,300 f/s).

Hazardous Shipping Description

Explosive, Blasting, Type E 1.1D UN 0241 II



DYNOSPLIT® ARCTIC

Technical Information



Transportation, Storage and Handling

- DYNOSPLIT ARCTIC must be transported, stored, handled and used in conformity with all applicable federal, state, provincial and local laws and regulations.
- Packaged emulsions have a minimum shelf life of one (1) year when stored at temperatures between -18°C and 38° C (0°F and 100°F). Explosive inventory should be rotated. Avoid using new materials before the old. For recommended good practices in transporting, storing, handling and using this product, see the booklet "Prevention of Accidents in the Use of Explosive Materials" packed inside each case and the Safety Library Publications of the Institute of Makers of Explosives.

Packaging

Diameter		Weight / Length		Length		Chubs per Case	Case Weight	
mm x 400	in x 16	kg/m	lbs/ft	m	ft		kg	lb
45	1.75	1.58	1.07	13.1	43	30	20.9	46

Note: All weights and dimensions are approximate.

Material Number: QG80145131

Case Dimensions

45.1 x 36.2 x 25.4 cm

17.75 x 14.25 x 10.0 in

Pallet Dimensions

91 x 109 cm

36 x 43 in

Cases / Pallet

42 Cases / Pallet

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