Auto-Stem Cartridges™ – the future of non-detonating explosive use

History of our company

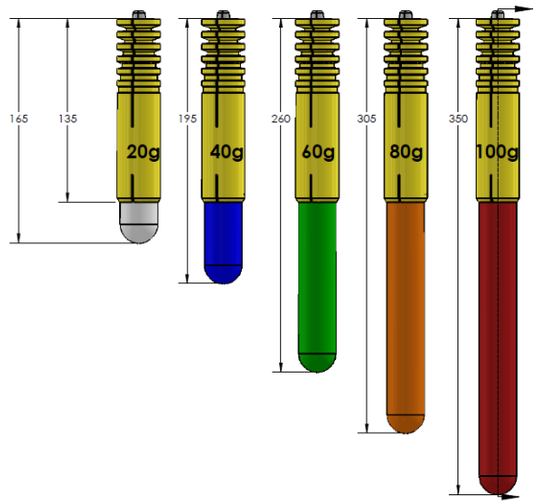
Time line	Company history
1997	▪ Founded in South Africa with the intention of developing a portfolio of innovative infrastructure technologies
1997-2001	▪ First to pioneer a non-detonating technology, based on a hydro-fracture concept
2010	▪ Launched Green Break™ Non-Detonating Safety Power Cartridges ▪ UN, SABS; SA chief inspector of explosives approved ▪ CE approved; Canadian Ministry of Mines
2012	▪ Auto-Stem™: the world's first "drop-and-go" concept developed ▪ Unique and novel concept - Patented and protected ▪ Non-detonating charge ***without*** the need for stemming ▪ Product is waterproof ▪ Hand-held sequential firing solution ▪ First viable mainstream alternative to conventional explosives

Accreditations and test parameters

- GBT Cartridges underwent a series of strenuous tests, in order to have it qualified in terms of the design claims

1. United Nations Series 1(a) and 6 tests (UN representative, Dec 2010)
2. Vibration (Council for geoscience, Mar 2011)
3. Ballistics (South African Bureau of Standards, Feb 2011)
4. Physical Sensitivity (Somchem, Mar 2011)
5. Chemical Stability (PMP, Mar 2011)
6. Modified Burning rate tests (UN representative, Mar 2011)
7. Water proofing test (UN representative, Jun 2011)
8. Methane test (SABS, May 2011)
9. Compatibility (RhineMetall Denel, Jun 2011)

Design characteristics of Auto-Stem Cartridges



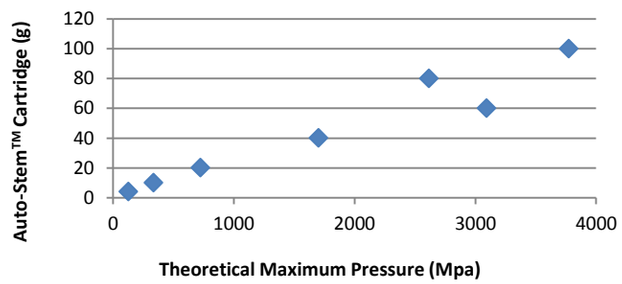
Technical characteristics

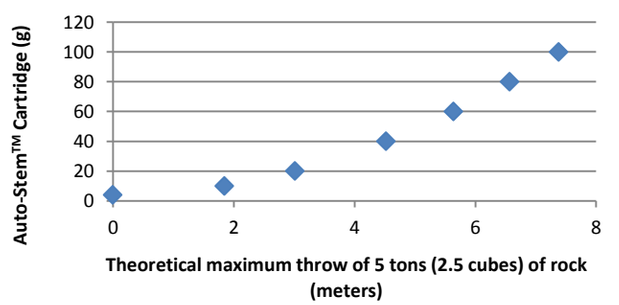
Characteristics	Measurement
Energy output	5,121 joules / g
Vibration (PPV)	< 2mm/s at 6m
Pressure	c. 400 Mpa

Gas composition	Percentage
Carbon dioxide	30.1%
Water vapour	39.5%
Nitrogen	28.3%
Carbon Monoxide	0.0%
Hydrogen	0.0%
Oxygen	2.0%
Ammonia	0.0%
Methane	0.0%
Potassium Hydroxide	0.1%

Technical data

- ✓ **Fragmentation:**
  - Minimal loss in fines and/or dust
  - High-value ore recovery
  - Good fragmentation size
- ✓ **Safety:**
  - No over-break detonation damage in tunnel ceiling / floor
  - Minimal fly rock: Clearing area of 20m
  - No harmful gases, minimal re-entry time
  - Does not impact on support infrastructure
  - No risk of auto-ignition and shelf life of 18 months
- ✓ **Ease of use:**
  - No required change over existing drilling patterns
  - No stemming required
  - "Drop-and-go"
- ✓ **Pressure**
  - Auto-Stem™ cartridges exhibit pressures far in excess of the required tensile strength of even the hardest Basalt rock (c. 35 Mpa)
  - Rock fractures long before pressure reaches theoretical maximum



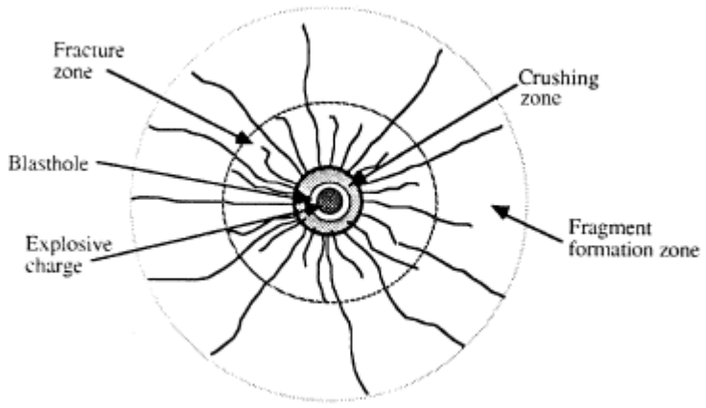


AUTOSTEM™

The World's First Self-Stemming Non-Detonating Cartridge

Improvements in safety, fragmentation and recovery

AutoStem eliminates the high explosive crushing zone



Rock type	Explosive density / Energy of combustion	Hole diameter	Borehole pressure (GPa)	Rc (Rc/Ro)
Clayey-limestone	0.803 g/cm3 3.812 Mj/kg	165mm	3.045	372mm (4.5x)
Clayey-limestone	0.994 g/cm3 3.918 Mj/kg	165mm	4.974	513mm (6.2x)
Basalt	0.803 g/cm3 3.812 Mj/kg	165mm	3.148	143mm (1.7x)
Basalt	0.994 g/cm3 3.918 Mj/kg	165mm	5.141	198mm (2.4x)

*International Journal of Rock Mechanics and Mining Sciences; Esen, S; Onederra, I; Bilgin, H.A., Feb 2003
*ANFO and WR ANFO explosive materials

Blasting geometry

- AutoStem™ blasting geometry a function of rock type; fragmentation requirement and production demands
- Underground application requires no change to conventional drilling approach
- Cost equivalent to conventional explosives per ton rock
- AutoStem will improve the existing mining conditions
  - Shaft call factors of 60-70%
  - Poor fragmentation is currently leading to poor commodity recovery rates
  - Explosive control becoming increasingly onerous
  - Hanging wall damage (FOG) leads to fatalities
  - One blast per day due to centralised blasting and long re-entry periods
- The adjacent image and table illustrates the pulverisation of ore using conventional explosives. Up to 6x the diameter of the borehole is reduced to dust resulting in what has today become a common mine call factor (or yield) of 70%

Furthermore…

- The applicability of the AutoStem in mechanised mining is a very promising possibility
- No handling of the AutoStem is required in its application, detonators are not required and a minimal clearing area renders the technology a very suitable candidate for use with robotic elements

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