Dragline stripping methods enhanced by explosives casting at Bridger Coal Mine

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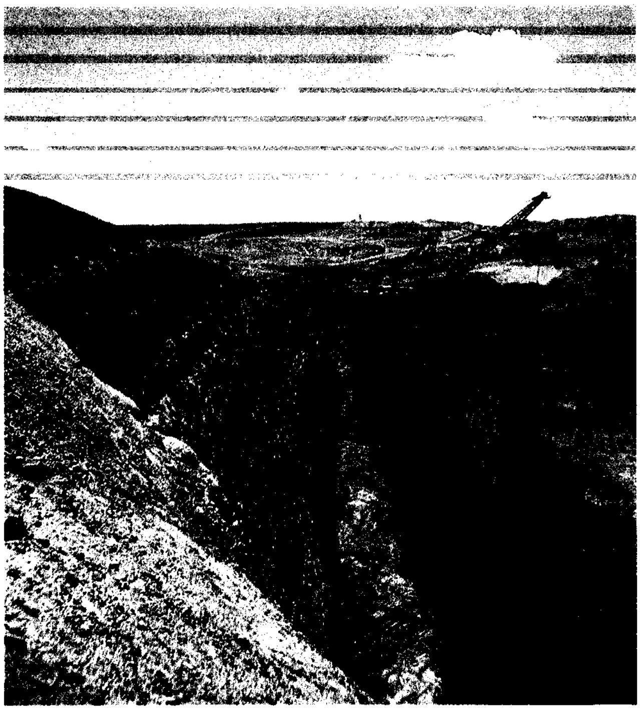
The Jim Bridger Coal Mine, operated by Bridger Coal Co., is located in Sweetwater County, WY about 56 km (35 miles) northeast of Rock Springs.

Bridger Coal is a joint venture between Nerco Coal Corp, the operator, and Idaho Energy Resources Co. The permit boundary encompasses more than 81 km^2 (20,000 acres) on the western side of the Continental Divide.

Since the mine began operations in 1974, it has produced about 82 Mt (90 million st) of coal while moving about 344 hm^3 (450 million cu yd) of virgin earth.

Annual production averages 4.5 Mt to 6.4 Mt (5 million to 7 million st) of run-of-mine coal. Coal is consumed on-site by the Jim Bridger Power Plant, a 2000-MW generating station. Electricity is transmitted to the Pacific Northwest power grid that includes Oregon, Idaho and northern California.



A dragline digs the key cut that establishes the lower lift highwall at Bridger Coal Co.'s Jim Bridger Coal Mine near Rock Springs, WY.

Geology

The mine is located on the northeast flank of the Rock Springs uplift. This is a broad, asymmetrical anticlinal feature about 97 km (60 miles) long and 56 km (35 miles) wide with a north-trending axis. This uplift separates the Green River Basin to the west and the Great Divide and Washakie Basins to the east.

Precambrian rocks on the apex of the uplift are estimated to be 5200 m (17,000 ft) above the Precambrian rocks in the Green River and Washakie Basins. Normal faults with generally less than 30-m (100-ft) vertical displacement cut through the uplift. The dip of strata on the flanks is generally between 3° and 15°.

The coal seams occur in the Deadman coal zone of the Fort Union Formation, which is Paleocene in age. The strike is generally northwest to southeast. This zone is about 18 to 24 m (60 to 80 ft) above the contact with the underlying Lance Formation. The Fort Union Formation is about 457 m (1500 ft) thick.

There are five coal seams exposed in the mine. They are designated D5 through D1 from top to bottom. Various combinations of these seams exist throughout the field forming single-seam, two-seam, three-seam and four-seam areas. The seams generally dip 2° to 5° to the northeast. An idealized cross section along the strike of the coal seams is shown in Fig. 1.

Sedimentary rocks of the Fort Union Formation represent depositional processes of a fine-grained, fluvial-flood-basin complex with extensive swampy conditions with minor lacustrine influence. Recognized depositional environments within the three-dimensional framework include poorly drained swamps, well drained swamps, crevasse splays and fine-grained channel sandstone deposits.

Overburden and interburden materials consist of interstratified sandstones, siltstones, claystones and minor shale and thin, discontinuous limestone stringers. These stratigraphic units exhibit a high degree of rock variability, laterally and vertically.

The coal resources are classified as subbituminous B. The energy content averages 21.8 MJ/kg (9400 Btu per lb) with 18% moisture, 9.5% ash by weight and 0.59% sulfur.

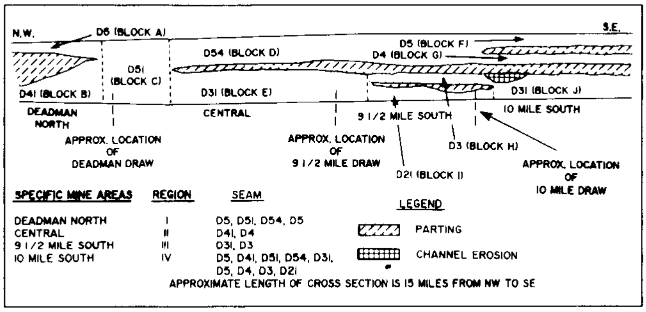


Fig. 1 — Idealized geologic cross section.

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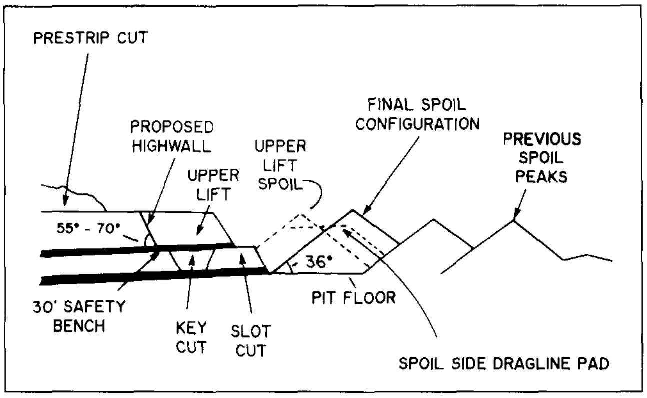


Fig. 2 — Typical pit cross section.

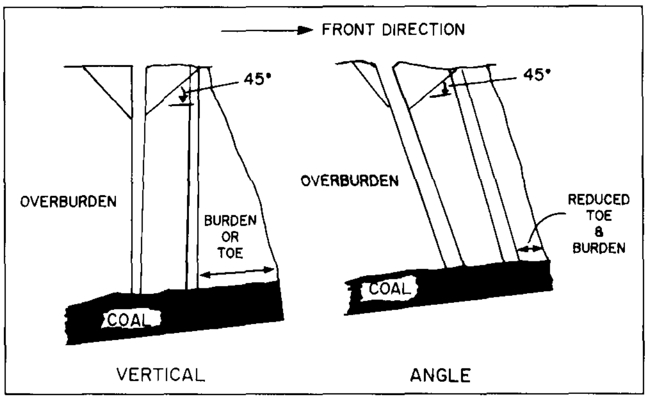


Fig. 3 — Breakage around a vertical and an angle blasthole.

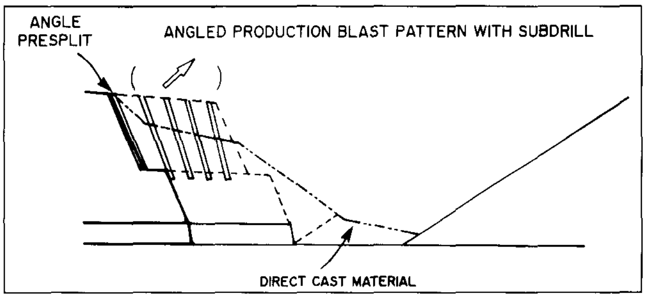


Fig. 4 — Upper lift cast blasting.

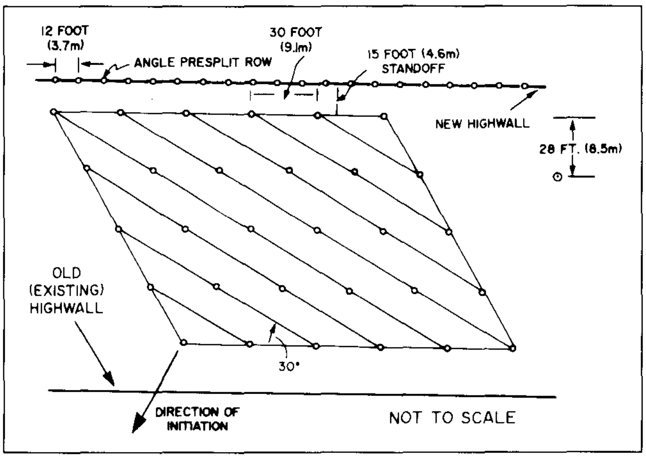


Fig. 5 — Right. Tie-in usng 4.6- x 9.8-m (28- x 30-ft) staggered pattern.

Pit orientation and development

General pit development is northwest to southeast along strike of the coal beds. Each successive pit is farther down the dip of the coal seams. Pit widths vary throughout the mine, but generally outcrop pits are 61 to 76 m (200 to 250 ft) wide.

Where the overburden is less than 46 m (150 ft), pits widths vary from 46 to 61 m (150 to 200 ft). For overburden depths greater than 46 m (150 ft) deep, pit width ranges from 37 to 46 m (120 to 150 ft). An overall average pit width is about 46 m (150 ft). Highwall angles generally range from 50° to 70°, with an average of 65°. The angle of repose for the spoil material is 36°. A typical pit cross section is shown in Fig. 2.

The active pit is about 18 km (11 miles) long. Spread across this area are four draglines, a fleet of truck and shovel operations and a scraper fleet operation.

Due to the length of the haul, coal is delivered with a 6400-m (21,000-ft) overland conveyor installed in 1989. A fleet of end-dump trucks shuttle coal from the pits to two truck dump sites feeding the conveyor system. Pit access is available through a series of ramps or entries spaced at about 1220-m (4000-ft) intervals.

Future mine development will consist of opening the remaining southern areas within the permit boundary. This will extend the pit about 6.5 km (4 miles). As the southern expansion is continued, final reclamation will begin in the northern active area. This development philosophy minimizes the total area disturbed and allows portions of the mine to return its original livestock and wildlife land use as soon as possible.

Dragline stripping with explosives casting

Early in the life of the mine, overburden depths were shallow enough that simple sidecasting and extended bench dragline stripping methods were used. As the overburden increased, a multiple-pass, spoil-side stripping method was implemented using conventional blasting techniques.

In the mid-1980s, the multiple-pass, spoil-side stripping method was modified to use explosives casting with vertical blastholes. Steep planes of geologic weakness oriented at a slightly skewed angle to the highwall led to situations of block sliding failure in the highwall, slabs and chunks of loose material from backbreak in the highwall, loss of coal recovery, poor highwall conditions and loss of dragline productivity. These experiences led to the abandonment of explosives casting with vertical blastholes.

A blasthole drill was retrofitted with an angle drilling attachment in 1988. Explosives casting was reintroduced with a presplit row of blastholes to define the highwall.

The entire production blasthole pattern was drilled 20° from vertical. Angle drilling reduces the backbreak because breakage around the top of the hole is directed toward the front of an angle blasthole, as shown in Fig. 3. Also shown is the reduction in excessive burden or toe distance from angle blastholes. Long toe distances prevent the face from moving off uniformly because the toe is still in place while the material above topples over it. Also, long toe distances increase the blasting energy forced downward into the coal. This causes damage and decreases the rock fragmentation in the lower region of the pit.

During the stripping operationg, the overburden is split into two lifts of approximate equal depth. The first, or upper lift is drilled and the material is cast blast into the empty pit (Fig. 4). To achieve this, a 20° angle presplit row is drilled along the orientation of the new highwall. A 3.7-m (12-ft) spacing between holes in the row is used with the

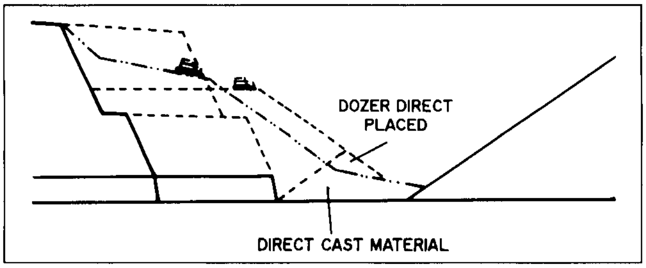


Fig. 6 — Dozer bench preparation of upper lift.

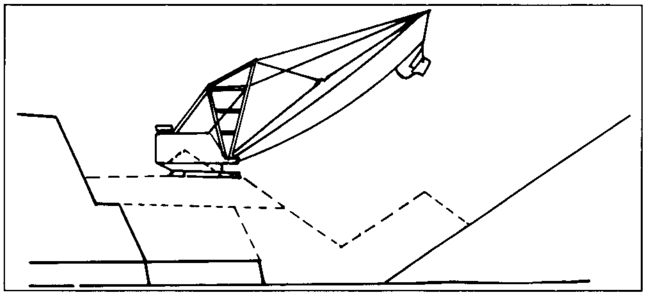


Fig. 7 — Remaining upper lift stripped by dragline.

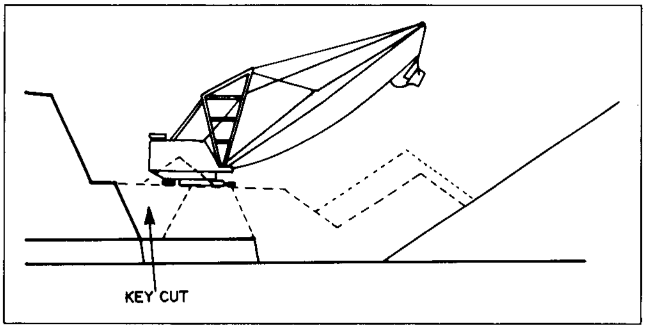


Fig. 8 — Lower lift key.

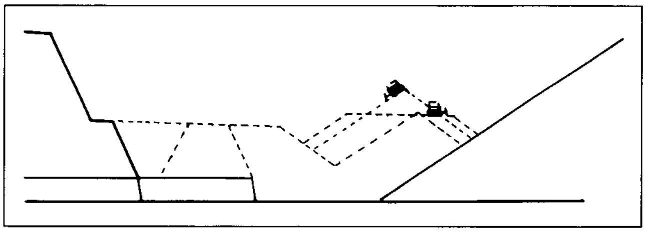
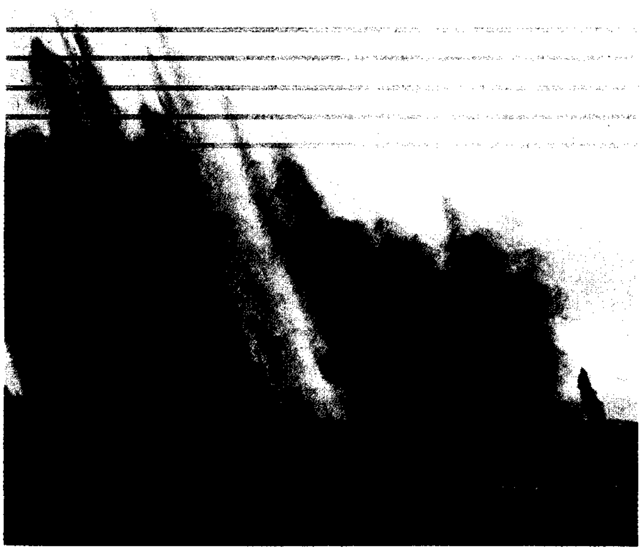


Fig. 9 — Dozer preparation of spoil side pad.


Presplit blast at the Jim Bridger Coal Mine.

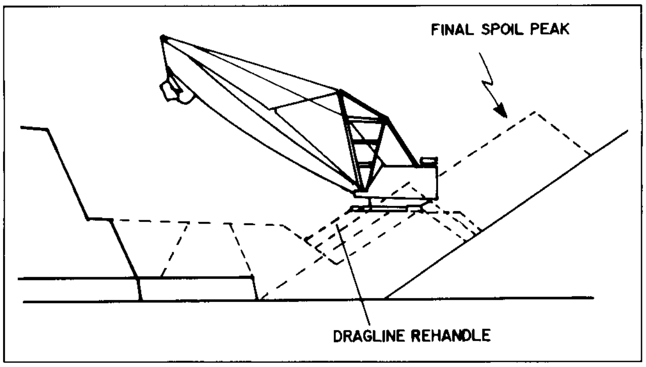


Fig. 10 — Stripping of remaining lower lift and final spoil placement.

holes loaded with 69 to 91 kg (150 to 200 lbs) of emulsion. The emulsion is used is a blend of 32% high energy fuel and 68% straight ammonium nitrate and fuel oil (ANFO). No stemming is used as the intent of the presplit is to create a fracture plane between blastholes. The presplit is shot separate from the production blast.

The main production is then drilled at a 20° angle using a 8.5- x 9.1-m (28- x 30-ft) staggered pattern. A standoff of 4.6 m (15 ft) from the presplit row is used to avoid backbreak. Powder factors average 19.2 kg/m^3 (1.2 lbs per cu yd) with a stem height of 6.7 m (22 ft). The emulsion mix can be adjusted from the normal 32-68 blend to a 50-50 blend for waterproofing. Using a 0.9-kg (2-lb) primer, a non-electric blasting system detonates the blast and is tied with a 30° flat angle from the highwall (Fig. 5).

Once blasting is completed for the upper lift, a dozer levels the post-cast profile and prepares the dragline bench (Fig. 6). Dragline stripping completes upper lift removal by sidecasting the material (Fig. 7).

After the dragline has cleared the upper lift, the lower lift material is drilled and blasted. A 10° angle presplit row is drilled to establish the toe of the highwall. The spacing is 3.7 m (12 ft) and the loading is reduced to 45.4 kg (100 lbs) with no stemming. The production blast is drilled vertically due to limited angle drilling capacity on a 9.1- x 9.8-m (30- x 32-ft) staggered pattern. A standoff of 4.6 m (15 ft) from the presplit is used for the production blast. Powder factors average 12 kg/m^3 (0.75 lb per cu yd).

The dragline maneuvers from the highwall elevation down a ramp cut out of the upper lift to the lower lift elevation. It strips a key cut that establishes the lower portion of the highwall and places that material behind and on top of the upper lift spoil (Fig. 8).

The entire upper lift and lower lift key cut spoils are leveled for a spoil-side pad for the dragline (Fig. 9). The dragline maneuvers onto the spoil-side pad. In this position, it strips the remaining lower lift material, spoiling the material to its final position (Fig. 10).

Direct blast cast benefit averages 20% to 30%, while the total blast casted material averages 44%. The direct cast blast is defined as the material cast into the final spoil pile. Total blast casted material represents the amount of material removed beyond the old highwall.

With the current practice of angle drilling presplit and production holes for blasting overburden, the problems created by the steep planes of geologic weakness have been overcome. Bridger Coal's current explosives casting program using angle drilling has continued to improve. The achieved benefits at this point are lower unit costs for stripping, increased coal recovery, improved dragline productivity and significantly safer highwalls. ♦