MMAA

Seminar 2010

Underground Operators
Mine Ventilation Officers Society

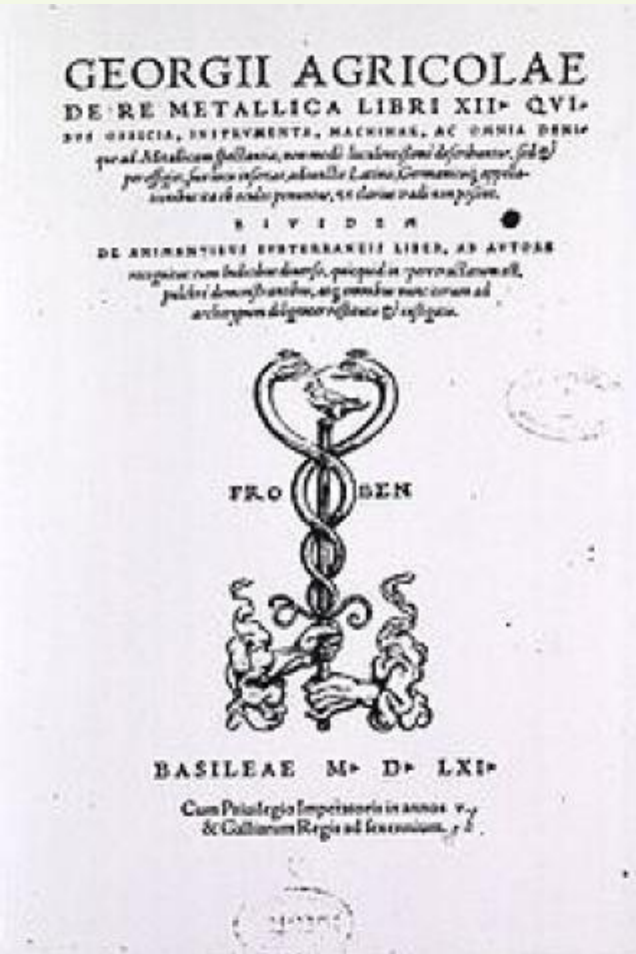
Centennial Coal

Optimisation of Ventilation

Allison Golsby

Belmont
10 & 11 June 2010

Latin Ventilation


GEORGII AGRICOLAE
DE RE METALLICA LIBRI XII. QVI-
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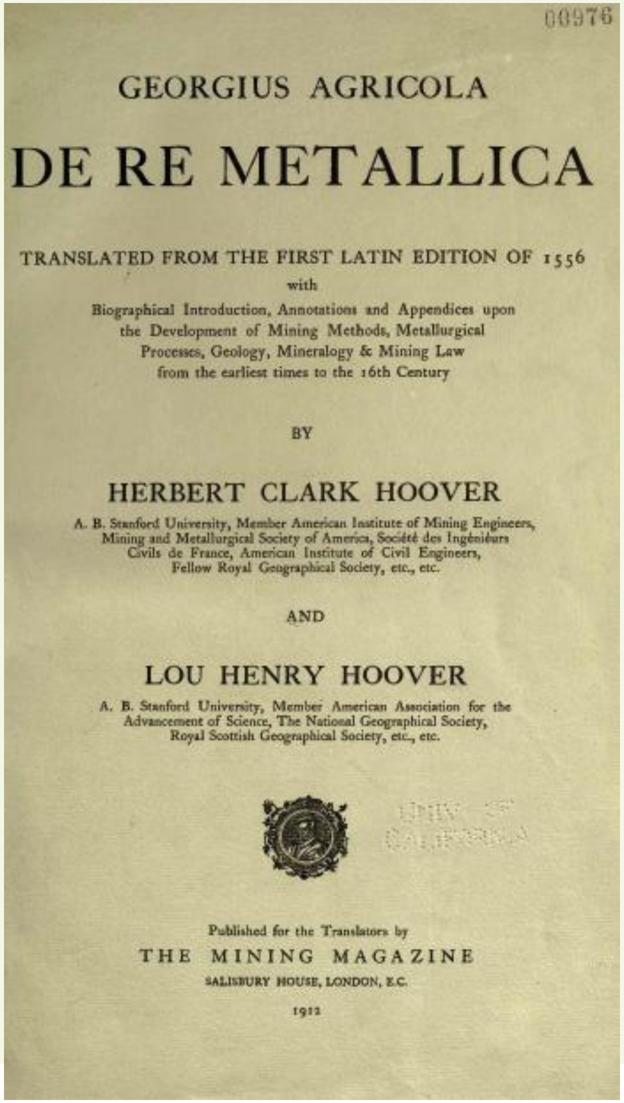
De re metallica **(Latin for *On the Nature of Metals (Minerals)*) is a book cataloguing the state of the art of mining, refining, and smelting metals, published in 1556.**

The author was Georg Bauer, whose pen name was the Latinized Georgius Agricola. The book remained the authoritative text on mining for 180 years after its publication.

In Book I: *Arguments for and against this art* Agricola explains that mining and prospecting are not just a matter of luck and hard work; there is specialized knowledge that must be learned. A miner should have knowledge of philosophy, medicine, astronomy, surveying, arithmetic, architecture, drawing and law, though few are masters of the whole craft and most are specialists.

In Book VI: *The miners' tools and machines* Agricola deals with the machines used in mines and with mining ventilation.

Latin Ventilation Translated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GEORGIUS AGRICOLA

DE RE METALLICA

TRANSLATED FROM THE FIRST LATIN EDITION OF 1556
with
Biographical Introduction, Annotations and Appendices upon the Development of Mining Methods, Metallurgical Processes, Geology, Mineralogy & Mining Law from the earliest times to the 16th Century

BY

HERBERT CLARK HOOVER

A. B. Stanford University, Member American Institute of Mining Engineers, Mining and Metallurgical Society of America, Société des Ingénieurs Civils de France, American Institute of Civil Engineers, Fellow Royal Geographical Society, etc., etc.

AND

LOU HENRY HOOVER

A. B. Stanford University, Member American Association for the Advancement of Science, The National Geographical Society, Royal Scottish Geographical Society, etc., etc.

Published for the Translators by
THE MINING MAGAZINE
SALISBURY HOUSE, LONDON, E.C.
1912

In 1912, the first English translation of *De Re Metallica* was privately published in London by subscription. The translators were Herbert Hoover, a mining engineer (and later President of the United States), and his wife, Lou Henry Hoover, a geologist and Latinist. The translation is notable not only for its clarity of language, but for the extensive footnotes, which detail the classical references to mining and metals, such as the *Naturalis Historia* of Pliny the Elder, the history of mining law in England, France, and the German states; safety in mines, including historical safety; and known minerals at the time that Agricola wrote *De Re Metallica.* Subsequent translations into other languages, including German, owe much to the Hoover translations, as their footnotes detail their difficulties with Agricola's baroque vocabulary.

Why Ventilate?

"If a shaft is very deep and no tunnel reaches to it, or no drift from another shaft connects with it, or when a tunnel is of great length and no shaft reaches to it, then the air does not replenish itself. In such a case it weighs heavily on the miners, causing them to breathe with difficulty, and sometimes they are even suffocated, and burning lamps are also extinguished. There is, therefore, a necessity for machines which the Greeks call πνευματικαί and the Latins spiritales though they do not give forth any sound which enable the miners to breathe easily and carry on their work".

Georgius Agricola, 1556 *De Re Mettallica,* (translated from the first Latin edition of 1556 by Herbert Clark Hoover and Lou Henry Hoover), pp200 - 212 (The Mining Magazine Salisbury House, London, E.G. 1912)

FUTURE POWER Centennial Coal

Ventilation Machines

"These devices are of three genera. The first receives and diverts into the shaft the blowing of the wind …".
"The second genus of blowing machine is made with fans, and is likewise varied and of many forms, for the fans are either fitted to a windlass barrel or to an axle".
"Blowing machines of the third genus, which are no less varied and of no fewer forms than those of the second genus, are made with bellows, for by its blasts the shafts and tunnels are not only furnished with air through conduits or pipes, but they can also be cleared by suction of their heavy and pestilential vapours".

Georgius Agricola, 1556 *De Re Mettallica,* (translated from the first Latin edition of 1556 by Herbert Clark Hoover and Lou Henry Hoover), pp200 - 212 (The Mining Magazine Salisbury House, London, E.G. 1912).

A—Wooden barrels. B—Hoops. C—Blow-holes. D—Pipe. E—Table. F—Axle. G—Opening in the bottom of the barrel. H—Wing.

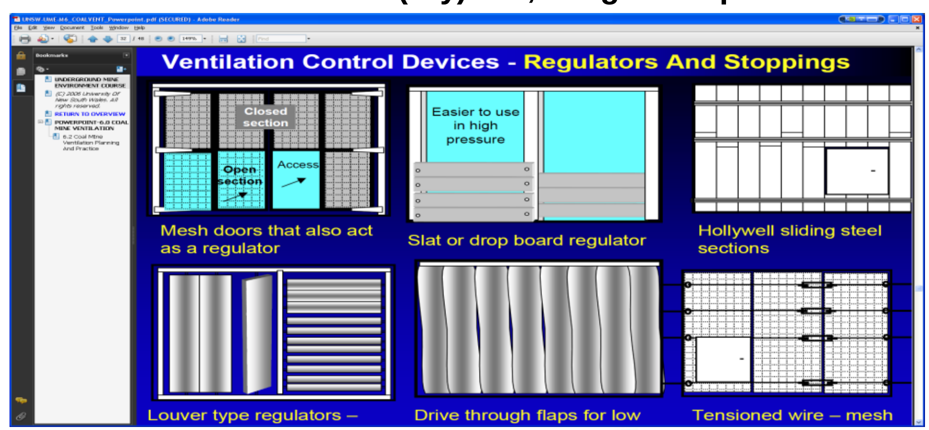
A—Tunnel. B—Pipe. C—Nozzle of double bellows.

A—Machine first described. B—This workman, treading with his feet, is compressing the bellows. C—Bellows without nozzles. D—Hole by which heavy vapours or blasts are blown out. E—Conduits. F—Tunnel. G—Second machine described. H—Wooden wheel. I—Its steps. K—Bars. L—Hole in same wheel. M—Pole. N—Third machine described. O—Upright axle. P—Its toothed drum. Q—Horizontal axle. R—Its drum which is made of rundles.

Modern Ventilation

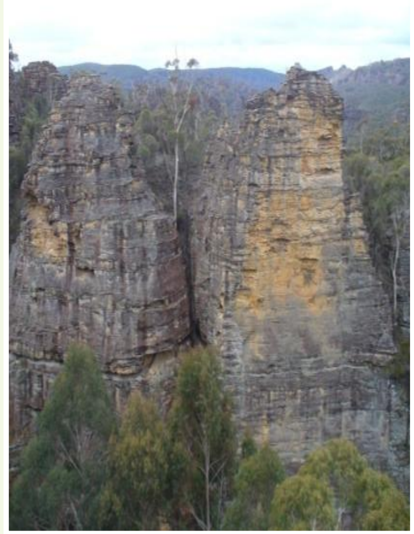
- Predevelopment gas drainage is increasing because methane is a valuable resource. Any gas drainage reduces the need during development and extraction to remove carbon dioxide and methane.
- The backbone of modern ventilation are fans that suck air, noxious and flammable gases out of shafts, causing air to be sucked into the mine.
- However, mine design ; the physical configuration and placement of shafts and drives; stoppings and brattice play an essential part in mine ventilation and could play a greater part.

BroKrew Industrial (Pty) Ltd, Krugersdorp RSA



Mine Design

- Maximise resource recovery while minimizing surface subsidence under sensitive features
- Mitigate groundwater inflow and disturbance to aquifers
- Locate drives and shafts to maximise natural geothermal ventilation
- Place stoppings and brattice to maximize ventilation
- Risk assessment
- Management and Monitoring
- Proactive Trigger Action Response Plans (TARP)



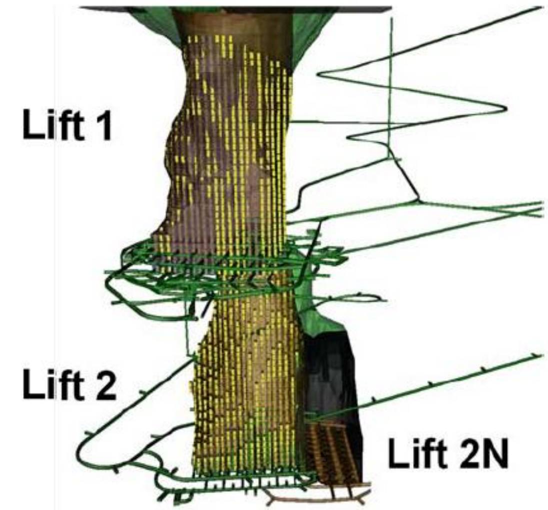


Figure 29 Northparkes E26 mining

Diering, Richter & Villa. 2008 *Block Cave Production Scheduling Using PCBC,* Gemcom Software International Inc., Vancouver, Canada

Technology

Innovative technology is being employed in coal cutting, transport and handling, strata control, ventilation and communications. Improved continuous miners; the introduction of Flexible Conveyer Trains to eliminate shuttle cars; new roof and rib bolts employed with newly developed resins and mesh; the use of PUR; newly developed monitoring equipment; the use of gas drainage; new dust suppression techniques; improved stoppings and fan management and the widespread adoption underground of leaky feeder communications will change the shape of underground coal mining in the next decade, allowing more coal to be cut with greater safety and consistency.

Much of this technology has been long employed in hard rock mining. Its implementation into coal mining was delayed by the necessity to make it intrinsically safe.

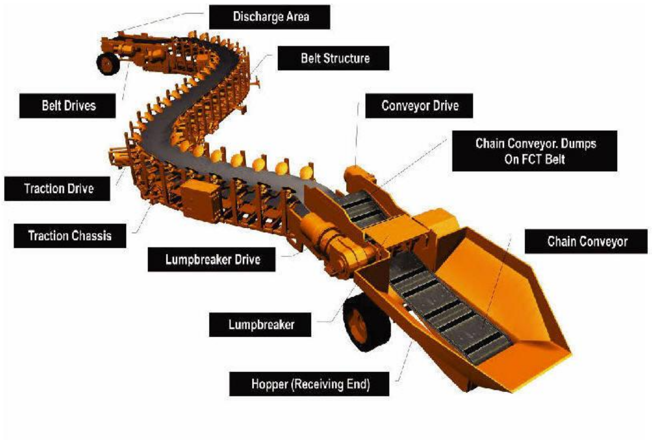


Figure 4 - FlexibleConveyer Train

No Technology

"The outer air flows spontaneously into the caverns of the earth, and when it can pass through them comes out again. This, however, comes about in different ways, for in spring and summer it flows into the deeper shafts, traverses the tunnels or drifts, and finds its way out of the shallower shafts; similarly at the same season it pours into the lowest tunnel and, meeting a shaft in its course, turns aside to a higher tunnel and passes out there from; but in autumn and winter, on the other hand, it enters the upper tunnel or shaft and comes out at the deeper ones. This change in the flow of air currents occurs in temperate regions at the beginning of spring and the end of autumn, but in cold regions at the end of spring and the beginning of autumn. But at each period, before the air regularly assumes its own accustomed course, generally for a space of fourteen days it undergoes frequent variations, now blowing into an upper shaft or tunnel, now into a lower one".

Georgius Agricola, 1556 *De Re Mettallica,* (translated from the first Latin edition of 1556 by Herbert Clark Hoover and Lou Henry Hoover), pp121-122 (The Mining Magazine Salisbury House, London, E.G. 1912)

A—Projecting mouth of conduit. B—Planks fixed to the mouth of the conduit which does not project.

A—Sills. B—Pointed stakes. C—Cross-beams. D—Upright planks. E—Hollows. F—Winds. G—Covering disc. H—Shafts. I—Machine without a covering.

No Technology

“Creighton 9-shaft workings are ventilated with 45,000 cubic meters (1.6 million cubic feet) per minute of fresh air, using a single pass system. Fresh air is drawn from the surface through a mass of broken rock located in old stopes in the vicinity of 3-shaft, which forms an “ice cavern” due to the cold winters and the moisture in the air. This ice-cavern acts as a heat exchanger, warming the air in the winter and cooling the air during the summer. The sub-surface air temperature averages 3 degrees Celsius (37 degrees Fahrenheit), with a small seasonal variation.

As a result of the ice cavern system, it has not been necessary to provide mechanical refrigeration so far. To date the savings in terms of plant, maintenance and power consumption have been very significant. Creighton was one of the first mines in Canada to employ this simplistic, though novel, ice-cavern cooling system”.

Vale Inco’s Creighton mine: Digging deeper by the day **in Viewpoint: perspectives on modern mining, a publication of Caterpillar Global Mining / 2008: issue4 © 2008 Caterpillar Inc. found at ww.cat.com.**

No Technology

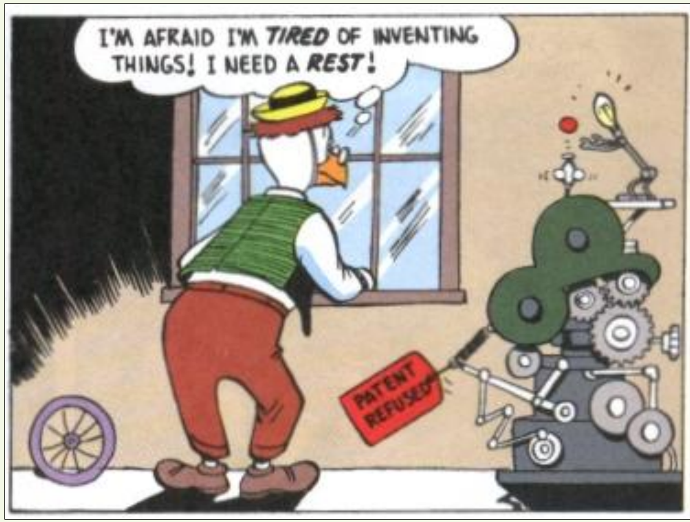
Nature can assist.

Mark Bain, an Undermanager at the Clarence Colliery reports that the Huntly West Coal Mine, in NZ operated for many years without fans because of a natural geothermal ventilation system that saw fresh air intake through the horizontal drives and exhaust via vertical shafts, with seasonal variations demanding only that stoppings and brattices be adjusted and relocated.

Fans were later installed, but augmented rather than replaced the natural geothermal ventilation.

4 x-cut East Return, intersection to east of Vent Shaft (half full of water)

Much Technology



At BHP Copper's San Manuel Mine, the block caving mining system is categorized into the upper levels in which haulage trains and armoured cribbed transfer raises are utilized. The second category is the new 3570 level in which conveyor belts are used to convey ore from the panels to the shafts.

The overview of the ventilation at San Manuel says it is "very simple". "Air is downcast through #1, #4, and #5 shafts to each production level; motivation is provided by a main intake fan on the main crosscuts of each production level. The air passes through this fan to the fringe drifts, and into the working panels through panel drifts. Airflow inside the panel splits east and west through grizzly lines and into the access drift. From the access drift air is drawn through low pressure booster fans exhausting to the haulage level. The air then courses north and south through panel haulage drifts to the main haulages which carry it to the four production shafts. These production shafts, #3A, #3B, #3C, and #3D, exhaust the air to the surface".

The current ventilation system uses roughly 8,150 Hp to intake and distribute 1,300,000 cfm throughout the mine.

Mine Ventilation System at BHP Copper San Manuel Division Underground Sulfide Operation **First Edition March, 1997 Magma Copper Company San Manuel, Arizona 85631. Revised by G. Lopez & D. Pelletier Contributors, Dr. K. Mutama T. Casten**

Much Technology

They then speak of bottom mounted 20Hp, 1760RPM fans moving 25,000cfm of air; the fans mounted at the top of Vent raises spaced about 1 per 3 or 4 grizzly lines; compressed air movers providing additional air movement in the grizzly lines; "conventional" primary drift driven with compressed air jumbos or jacklegs, compressed air mucking machines; headings driven using a blowing ventilation system which picks up air from a nearby turnout or crossover drift; vent lines typically 24 in. diameter fibreglass or galvanized pipe; 20Hp, 25¼ fan used to provide 7,500 cfm for a 500 ft. drive in series on 500 ft increments; 50-ton, 7,000 cfm refrigeration units to provide cooling in the headings; "LHD" primary drifts a blowing system with 30 to 42 in. fibreglass or vent bag vent line; 36 in., two stage, 1760 rpm, 60Hp, fans providing 17,000 cfm for a 900 ft. drive; .5 to 2-yd loaders with a forced air distribution system using 24 in vent bag; a single electric 40 hp (Jetair 25.25-17.5-1750) fan to provide air up in the undercut; small 16 in. compressed air fans, vent bag, and air movers are then used to distribute air for the ½-yd loader; LHD grizzly lines are ventilated with either a 20 or 40 hp fan.

They also note that the ventilation system can be set up as either a blowing or exhausting system. The location of vent raise fans or transfer raises determines which type of system will be installed.

Mine Ventilation System at BHP Copper San Manuel Division Underground Sulfide Operation
First Edition March, 1997 Magma Copper Company San Manuel, Arizona 85631. Revised by G. Lopez & D. Pelletier Contributors, Dr. K. Mutama T. Casten

Over Ventilation

- Many mines waste power and energy with inefficient systems and ineffective technologies.
- There are ways to avoid over ventilation and save money by reducing power consumption.
- Identifying areas for power savings based on previous expenses and bills
- Appropriately selecting downtime for unneeded secondary fans in order to avoid unnecessary power use
- Adapting telemetry technology on site to control fans from the surface

Figure 2 Tele-Remote Operator Station

Swadling & Dudley 2004 *VRLoader – a Virtual Reality Training System for a Mining Application* Northparkes Mines

A Balance: Some Technology

- The keys are management and monitoring. If it can not be measured meaningfully, it can not be optimised.
- The answer to ventilation problems should never be to just turn up the fans and pump more air in.
- An effective Ventilation Management Plan will ensure that the physical structures are in place necessary to get air flowing where and when needed, as effectively as possible.
- Air may not be getting to the coal face at sufficient pressures because the ventilation appliances are not effective, ventilation apertures are not optimal, or there is unnecessary resistance in the ventilation circuit.
- Pressure and resistance tends to drive a ventilation circuit, with both total pressure and velocity pressure influencing how ventilation can be optimised in a circuit.
- Low cost ventilation management relies on pressure and resistance to make these systems function. Another way to measure this, is to see how many regulators are in the mine, ideally one.
- Monitoring allows for the early warning of the build-up of Carbon Dioxide and/or Methane. Gas drainage can minimise their levels. Monitoring also enables air flows to be made effective.
- The Geothermal structure of the mine may impact upon airflows, ventilating in through drives and exhausting through vertical shafts.

Considerations and Contingencies

- Review of current management operating practices for mining and support sequences; production and maintenance planning and ventilation control
- Formulation of Ventilation Management Plan
- Formulation of Explosive Hazard Management Plan
- Formulation of Dust Hazard Management Plan
- Formulation of Gas Hazard Management Plan
- Trigger Action Response Plan (TARP) must outline the contingencies in a breakdown
- Accepting and applying agreed processes.
- Measuring, monitoring and reviewing performance

Compliance,Communication & Consultation

- Mine Ventilation in most jurisdictions is closely and comprehensively regulated.
- Compliance, effective communication, and consultation, with the workforce, improves the safety, production and system interactions, into the future.
- Regular meetings with employees for implementation of the ventilation system outlining steps in design, construction, commissioning and operation
- Ongoing involvement of people from different shifts/ disciplines, seeking contribution in dealing with potential changes in production, service and specialist support activities
- Training and involvement of tradespersons and operators.

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Allison Golsby

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Thank You
Any Questions?

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