July 16, 1963 R. F. LOVE ETAL 3,097,830

MINING METHODS AND SYSTEMS INCLUDING CAVING TO RELIEVE PRESSURE

Filed Oct. 3. 1960 2 Sheets-Sheet 1

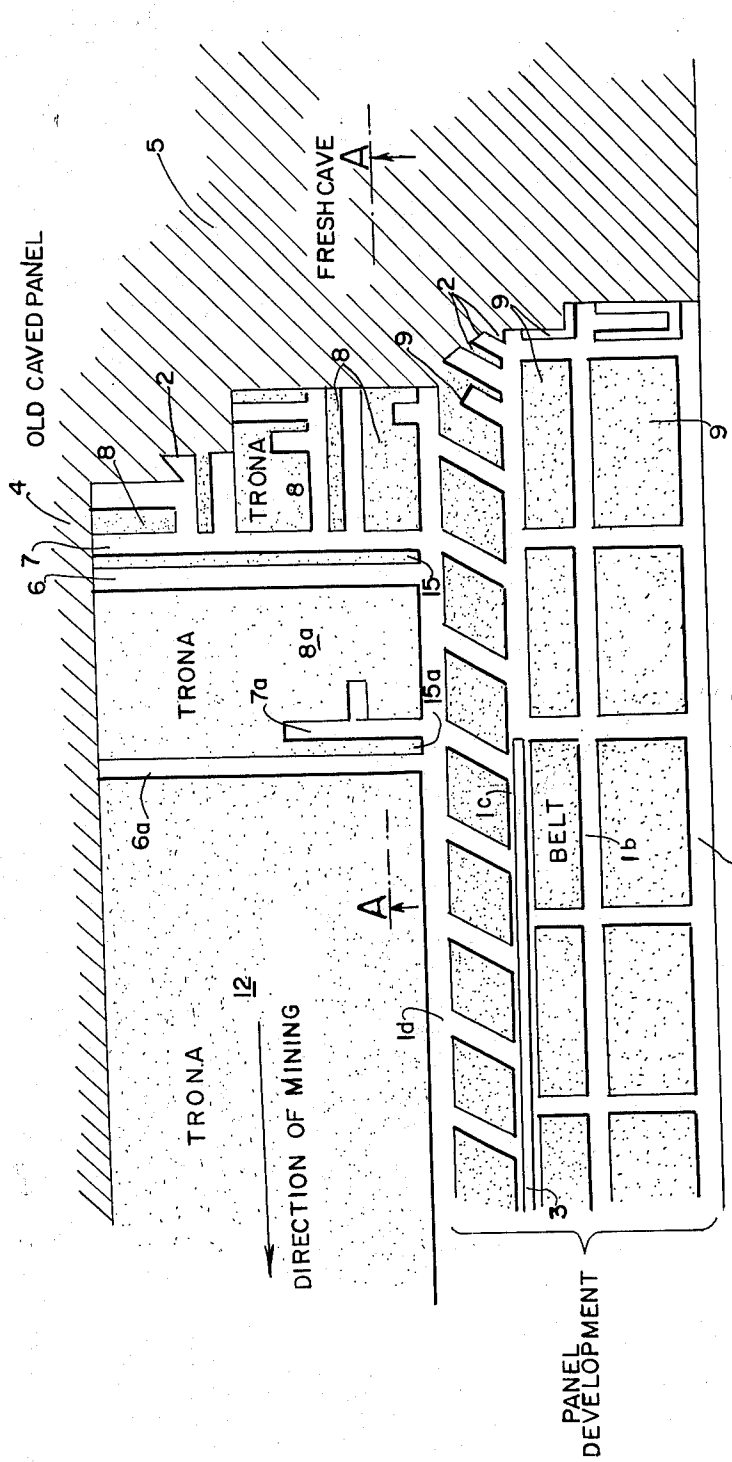


Fig. 1

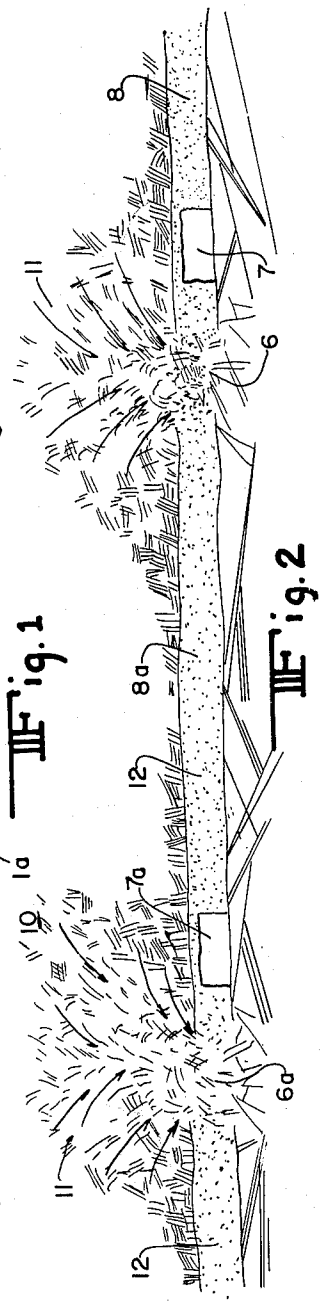


Fig. 2

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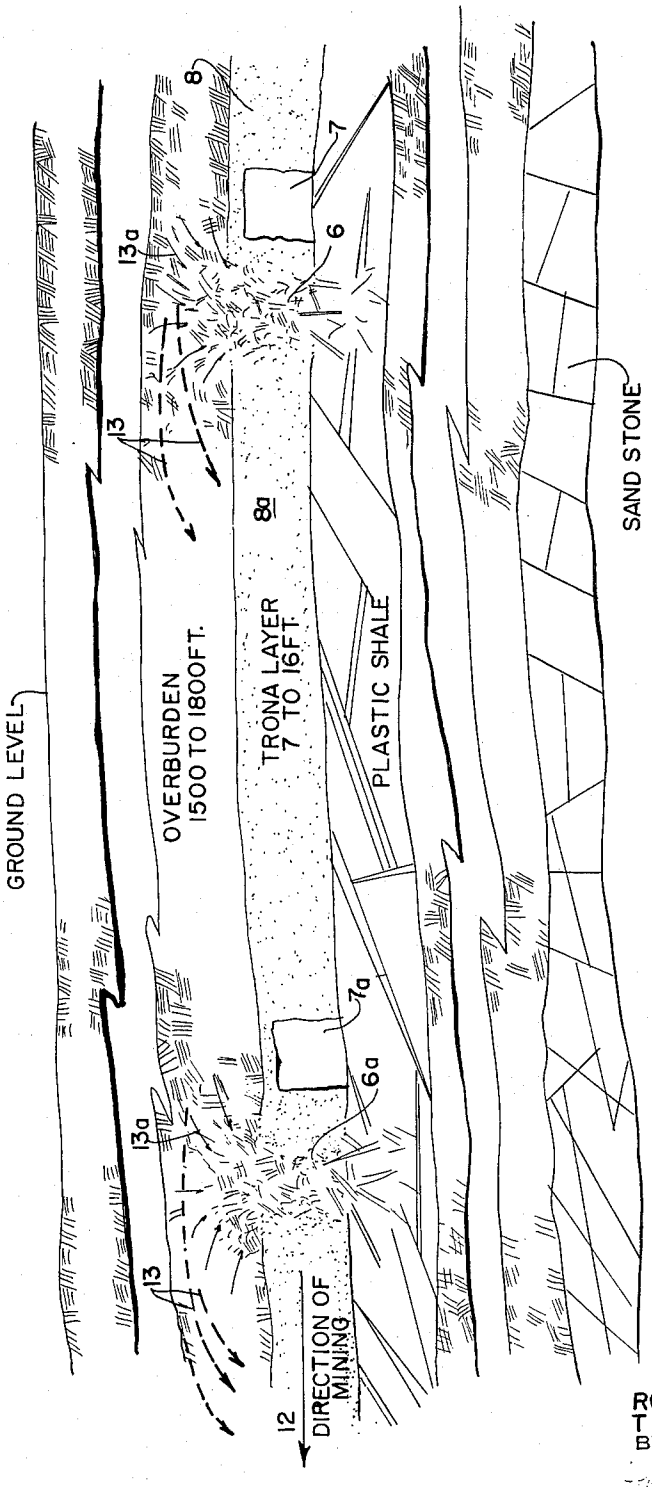


Fig. 3

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MINING METHODS AND SYSTEMS INCLUDING CAVING TO RELIEVE PRESSURE

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This invention relates to the mining of trona as found in Sweetwater County and adjacent counties in southwestern Wyoming and in similar trona deposits found elsewhere.

The trona deposits in Sweetwater County and adjacent counties in Wyoming consist of a main trona bed having a varying thickness up to about 16 feet, averaging more nearly 7 to 13 feet, located at a depth of about 1500 to 1800 feet underground and of several thinner beds. Only the main trona bed is mined. Because of its great depth below the surface and its relative hardness, the main Wyoming trona bed is difficult to mine and this difficulty is increased by the fact that the main trona bed is stronger than the formation above and below it.

The main trona bed lies substantially horizontal. The overlying strata are also horizontal in attitude and are chiefly composed of unconsolidated shales and fine grained sandstones. The 400 feet of strata immediately above the main trona bed are mainly weak, laminated grey shales and oil shale, and an approximately 8 foot bed of somewhat plastic oil shale lies immediately below the main trona bed.

The comparative strength of the main trona bed and of the overlying and underlying shale layers in average values is substantially as follows:

	Compressive strength, p.s.i.	Tensile strength, p.s.i.
Trona	7,500	500
Roof Shale	3,700	60
Floor Shale	3,700	400

Where the trona supporting layer is completely removed as in a mining tunnel or by drawing a pillar, neither the roof shale nor the floor shale have sufficient strength to sustain the additional burden placed thereon. The roof shale therefore caves and the floor shale heaves into the mining cavities.

These conditions make conventional mining operations very difficult because unlike coal and similar mining operations under a slate, compacted sandstone or other firmly compacted roof, trona mining essentially comprises removing the only strong layer in the formation and leaving an essentially weak roof that is incapable of supporting itself over large spans, while the plastic shale immediately below the trona bed is pushed upward into the mine cavity when the overlying weight, effecting vertical compression of the plastic shale, is relieved by the removal of a portion of the trona bed in the mining operation.

In past Wyoming trona mining operations, it has been the practice to mine essentially rectangular tunnels in the trona formation according to the conventional room-and-pillar mining system by shear cutting and drilling the trona mining face and blasting out the trona.

The trona is mined from secondary entries by the room-and-pillar method commonly used in mining coal. Normally in mining the pillars, rooms fifteen feet wide are first driven at right angles to the secondary development. Several rooms are started at the extreme end of the development entries with the room closest to the unmined trona bed being completed slightly before the others.

The rooms are spaced about 50 to 60 feet apart and the resulting pillar between them is extracted. The extraction is normally done by driving lifts twenty feet wide through the pillars starting from the ends of the rooms farthest from the development entry. The lifts are usually driven at right angles to the rooms, and hence parallel to the secondary development entries, and are separated from the mined out area by a narrow fender of trona, fixe feet or less in thickness. When a lift is completed, the fender is removed by blasting and the unsupported roof, adjacent the previously mined out and caved area, will cave. Thus the mined out areas are caved to relieve the roof and floor pressure adjacent the mined out areas soon after the extraction of each section of a pillar is finished.

When one lift has been driven and the fender blasted, the next parallel lift is started, also leaving a five foot fender between it and the previously caved section until it is completed, and this process is repeated until the entire pillar has been drawn and the roof thereover caved. The rooms are driven in a direction at right angles away from the entries and the pillars are extracted by lifts at right angles to the rooms or parallel to the entries moving back toward the entires, or on the retreat. Prior to caving, the roofs of all entries, rooms and lifts are supported by roof bolts, preferably on four foot centers, which are removed as much as possible before caving. Timbering is used whenever necessary.

Due to the great depth of the trona beds and the overburden weight, the unplanned roof failures and floor heaving in the pillar extraction areas have become so excessive as to make the mining operation very hazardous and costly, requiring elaborate timbering in some instances and in other instances requiring the abandonment of mining in specific areas before all the pillars have been drawn.

One of the objects of this invention is to provide a method of still further reducing overburden pressures in trona mining pillar extraction areas which will reduce the mining hazards and provide safer mining conditions.

Another object of the invention is to provide a method of protecting the pillar extraction areas from premature or unplanned caving which will reduce the previous cost of timbering and permit complete pillar extraction before necessity for abandoning a give area.

Other objects and advantages of the invention will appear as this description proceeds.

We have found that part of the pressure on the pillar extraction areas is due to the superincumbent overburden weight and that the pillars act as abutments in the working area or room. This excess overburden pressure can be reduced or dispatched to other more remote areas by driving a room between the room used for mining the active pillar extraction area and the still unmined trona area and permitting this first room to cave so that the caving extends a substantial distance up into the overburden. After caving of a room between the active mining area and the unmined trona area or pillar, the pillar can be extracted by driving another room very close to the caved room, and lifts can then be driven to the cave line and the pillar removed. In this manner, pressure on the active pillar extraction area is reduced and mining conditions rendered less hazardous and mining less costly.

Referring now to the drawings which illustrate a preferred embodiment of the practice of our invention:

FIG. 1 is a plan view at the mine level illustrating an application of our invention;

FIG. 2 is a section view on an enlarged scale along the line A—A of FIG. 1; and

FIG. 3 is a section view through a larger area of the formation also substantially on the line A—A of FIG. 1.

As illustrated in FIG. 1, a four entry secondary development panel **1** consisting of entries **1***a*, **1***b*, **1***c* and **1***d* has been driven into the trona mining area **2** and communicates at the left side of the drawing with the main development entries (not shown), through which the men, machines and supplies, etc. are brought into the mine and the mined trona removed. A belt conveyor **3** is shown in entry **1***c* on which mined trona brought from the active mining areas **2** is deposited for conveyance out of the mine. The previously caved panel area is shown at **4** and the freshly caved areas adjacent the active mining operation is shown at **5**.

In applying the principles of our invention rooms **6** and **6***a* are first driven at right angles to the secondary development entry **1***d*, through the bed of trona, to the old caved panel **4**, and rooms **7** and **7***a* are immediately driven parallel to and between the first rooms **6** and **6***a* and the caved ground **5** from the freshly completed pillar extraction operation. The rooms **6** and **7** and **6***a* and **7***a* are usually left separated by approximately ten foot pillars **15** and **15***a*. While two rooms **6** and **6***a* and two alternate rooms **7** and **7***a* (one not completed) have been shown to better illustrate the application of our invention, it will be understood that the mining operation may be moved backward in the direction of mining indicated by the arrow **12**, one pillar at a time, in which case only one room **6** will be driven and one alternate room **7**, and after the pillar **8** between the room **7** and the previous mining area **5** has been completely extracted and the area caved, a second room **6***a* and a second alternate room **7***a* is driven and the new pillar **8***a* is mined.

The pillar **8** between the room **7** and the previous mining operation is shown in the process of being mined. Mining of the pillar **8***a* is started when room **7***a* is completed to caved area **4**. As the pillars **8**, **8***a*, etc. are being mined by retreat on the entries **1**, **1***a*, **1***b* and **1***c*, the supporting pillars **9** left between the entries are also extracted to remove the trona therein and cave the secondary development panel area **1***a*, **1***b*, **1***c*, etc., as well as the room-and-pillar area **8**, **8***a*, etc. The mining of the room pillars **8**, **8***a*, etc. is conducted slightly in advance of the mining of the entry pillars **9**.

Ventilation of the working areas is carried out through entries **1***a*, **1***b*, **1***c* and **1***d*, and when it is desired to ventilate the caved area **5**, as required by some mining laws, it is best to leave one row of pillars in place so that air may be conducted through entry **1***a* and the cross entries therefrom into the caved area **5**. In this manner, fresh air is kept circulating through the cave areas.

The rooms **6**, **6***a*, etc. are left untimbered. These rooms then cave within a few days after they are driven, with the caving extending sufficiently far up into the overburden **10**, as indicated at **11**, to break the weight of the overburden on the unmined trona layers **12** so that the pressure on the alternate rooms **7** and **7***a* and the pillars **8** and **8***a* is reduced sufficiently to permit mining of the pillars **8** and **8***a* without undue hazards and costs. The majority of the roof failures and floor heaving takes place in the first rooms **6** and **6***a* and the second rooms **7** and **7***a* remain relatively good and pillar extraction between the rooms **7** or **7***a* and the previously mined area may proceed under much more safe and workable conditions. Any roof bolts installed in rooms **6** and **6***a* are recovered if this can be done safely.

FIG. 2 shows a partial cross section through the mine area and indicates, by the arrows **11**, how a portion of the overburden has been caved into the rooms **6** and **6***a* to partially break the superincumbent effect of the overburden over the unmined portions **12** of the trona bed.

As indicated in FIG. 3, which is a diagrammatic cross-section through the formation, the trona layer is approximately 1500 to 1800 feet below the earth's surface. This figure illustrates the theory of the invention. The shale beam roofs of the rooms are weak and will not support much overburden weight before cracking and

beginning to cave. Part of the superincumbent weight of the overburden of the roofs must be supported by the pillars **8** and **8***a* on the abutments formed by the vertical walls of these pillars, and the amount of superincumbent overburden weight that the pillars **8** and **8***a* must support is a function of the percentage of extraction of the pillars.

When the first rooms **6** and **6***a* cave as shown by arrows **13***a*, it is believed that horizontal pressures and deformations towards the caved rooms cause the extra superincumbent weight that the pillars **8** and **8***a* must bear to move back to more solid and confined ground in the direction of arrow **13**. This effects an apparent pressure relief in the vicinity of the deliberately caved rooms **6** or **6***a* as the horizontal confining stress, which normally opposes Poisson's ratio applied to the vertical weight, can not develop in this region. In this manner, any vertical weight is transmitted away from the mining area due to the deformation of the soft shale beds towards the caved areas.

While we have shown a preferred embodiment of our invention and set forth certain theories as to why we believe the caving of rooms **6** and **6***a* relieves the pressure on the active mining areas, we have in any event found this to be the fact regardless of whether the theories advanced herein are correct or not. It will be understood that the invention can be practiced in other ways than according to the preferred embodiment herein illustrated and that various modifications and changes can be made in active mining operations within the spirit of our invention and the scope of the following claims.

We claim:

1. The method of mining trona by the room-and-pillar system and of relieving overburden pressure on the pillar extraction area, which comprises driving two substantially parallel rooms spaced approximately 10 feet apart between the active pillar extraction area and the unmined trona area, caving the room nearest the unmined trona area, extracting the pillar in the pillar extraction area from the parallel room nearest the pillar extraction area and when the pillars have been extracted caving the roof over the pillar extraction area and advancing the mine in the direction of the unmined trona area by driving two further parallel rooms spaced approximately 10 feet apart between the pillar area to be extracted and the unmined trona area, caving the room nearest the unmined trona area and extracting the pillar in the pillar extraction area from the uncaved room between the caved room and the pillar extraction area and continuing this process in advancing the mine in the direction of the unmined trona area.

2. The method of mining trona and relieving overburden pressure in the mining operation which comprises driving two adjacent rooms into the trona bed between the active mining area and the unmined trona area, the said rooms being close enough so that upon caving the room adjacent the unmined trona area the overburden pressure will be reduced to avoid unplanned, premature caving in the active mining area, caving the room adjacent the unmined trona area and, mining the pillars in the active mining area from the uncaved room.

3. The method of mining trona and relieving overburden pressure in the mining operation which comprises driving two adjacent rooms into the trona bed between the active mining area and the unmined trona area, the said rooms being close enough so that upon caving the room adjacent the unmined trona area the overburden pressure will be reduced to avoid unplanned, premature caving in the active mining area, caving the room adjacent the unmined trona area, mining the pillars in the active mining area from the uncaved room and caving the roof over the pillars in the active mining area as the pillars are mined.

4. The method of mining trona by the room and pillar system and of relieving overburden pressure on the pillar

area undergoing extraction which comprises driving two substantially parallel adjacent rooms between the pillar extraction area and the unmined trona area, the said rooms being close enough so that upon caving the room adjacent the unmined trona area the overburden pressure will be reduced to avoid unplanned, premature caving in the active mining area, caving the room adjacent the unmined trona area and proceeding with the extraction of

the pillars in the pillar extraction area from the room adjacent to the active mining area.

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