

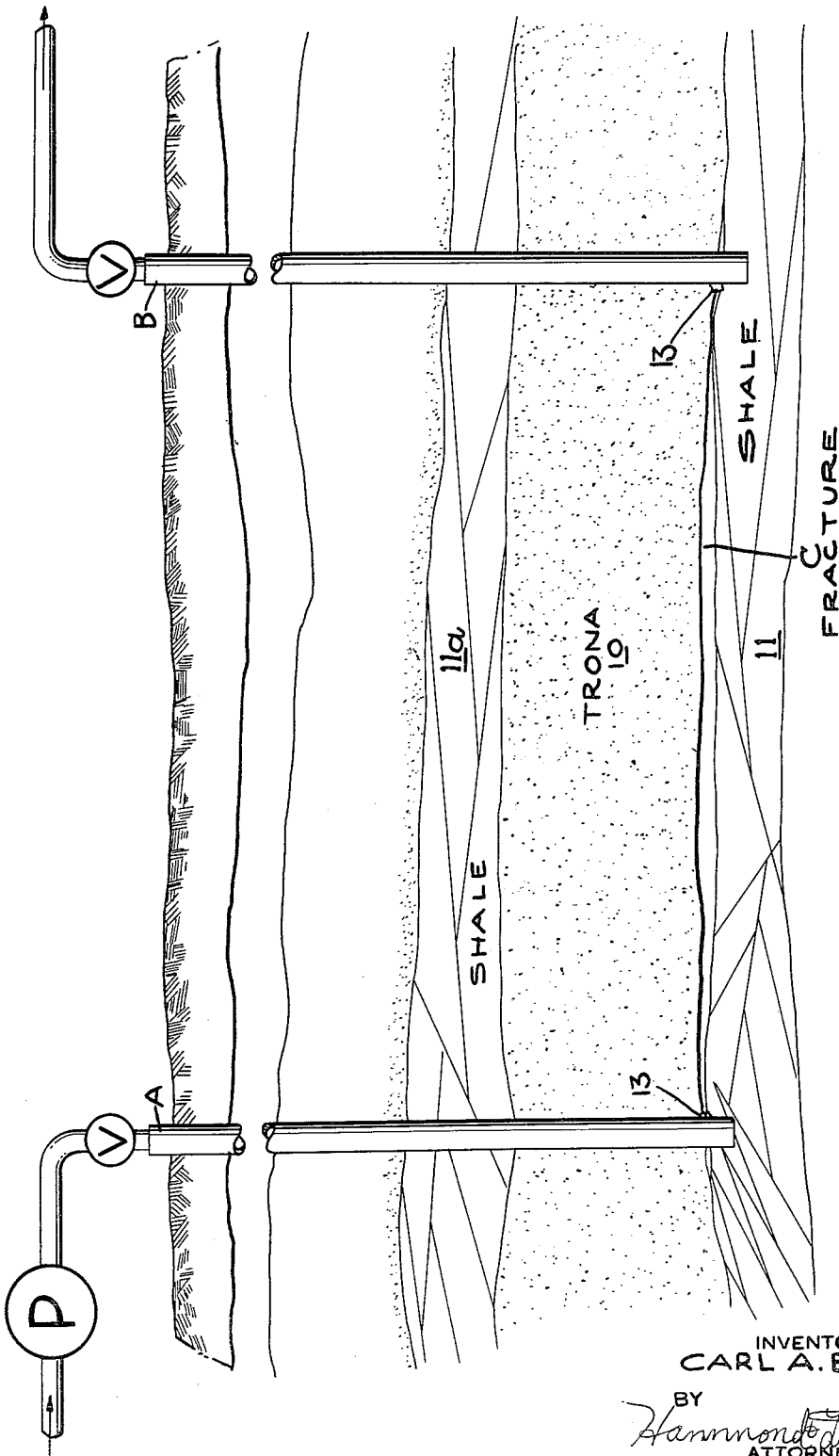
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METHOD OF CREATING AN UNDERGROUND COMMUNICATION

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METHOD OF CREATING AN UNDERGROUND COMMUNICATION

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This invention relates to a method of exposing underground deposits to solution mining. Examples of such deposits are underground salt, potash, trona beds, sulfur and the like.

This application is a continuation-in-part of my co-pending application Serial No. 628,485 filed December 17, 1956, now abandoned.

A relatively recent practice employed by the oil and gas industry is that of hydraulically fracturing the underground formation. The purpose of this technique is to increase the permeability of the formation adjacent the producing well, thereby increasing the oil recovery. By hydraulic fracturing, the earth formation lying above the plane of fracture is separated from the underlying earth. This may be brought about by hydraulically applying pressure to the formation in order to overcome the effective parting pressure of the particular formation.

While the formation may be thus fractured, once the pressure is relieved, the earth formation has a tendency to resettle and thus, renders it impossible to gainfully operate the well.

To overcome this disadvantage, it has been the prior practice to introduce propping agents into the formation along with the fracturing fluid. The propping agents function to prevent the earth formation from resettling or resealing when the pressure along the fracture line is returned to normal formation pressures.

Examples of such propping agents are sand particles, glass beads, ceramic particles, metal particles and the like.

Propping agents of the type mentioned above when strategically placed along the line of fracture will support the upper portion of the parted formation. However, a practical problem which renders the use of propping agents as supporting means unsatisfactory, is that of the strategic placement of the propping agents along the line of fracture so as to insure a continuing line of fracture between two points in an underground formation.

Likewise, when employing hydraulic fracturing for the recovery of certain minerals by passing a solvent suitable for dissolving the formation between two or more wells as described in U.S. Patent No. 2,847,202, the reclosing of the formation, after the initial fracture has occurred and the formation is returned to normal pressures, prevents satisfactory solution mining of the formation because when a fractured formation has resettled innumerable cracks, crevices and fissures are formed in the salt or earth formation, generally along and at angles to the original fracture line, into which a dissolving or removal liquid or fluid can penetrate, and flow at angles to the line of the original fracture and while the formation may remain porous, along the original fracture the innumerable pores direct the dissolving liquid in innumerable, undesired directions and retard the rapid formation of a large open dissolving path through the formation from which a rapid production can be attained.

An object of this invention is to provide a novel means for bringing about an underground communication between two points.

It is a further object of this invention to provide a novel method for rapidly exposing an underground deposit to solution mining.

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Another object is to provide a process for creating an underground communication between two wells in which a pressure sufficient to maintain the initial line of fracture between two wells open by supporting or floating the overlying formation on the fracturing liquid is exerted on the underground formation while continuously passing a solvent for a portion of the underground formation along the line of fracture between said wells to dissolve out a clear channel between the wells, after which the pressure is relaxed and the formation permitted to return to its normal environmental pressure.

A still further object of this invention is to provide a method for the recovery of underground deposits by hydraulically fracturing said deposits without the use of propping agents.

Another object of this invention is to provide a method of fracturing and dissolving trona from underground trona deposits whereby settling, cracking and resealing of the trona deposit after fracturing is prevented.

Other objects of this invention will become apparent as this description proceeds.

Generally stated, this invention provides a process for the solution mining of an underground deposit whereby, during the creation of the underground communication, a pressure sufficient to maintain open the initial line of fracture and support the overlying fractured formation on the fracturing fluid is exerted on the underground formation while continuously passing a solvent suitable to dissolve the formation along the line of fracture.

By operating in this manner, an underground void of considerable dimension is created between two or more spaced wells so that when the formation is returned to normal environmental pressures, the formation will not reseal or resettle.

In opening underground deposits to solution mining it is desirable that the flow of solvent be between wells drilled into the formation. The dissolving liquid is pumped down one well and is recovered from another.

To create an underground fracture by hydraulic fracturing a well may be sunk into the formation to the desired depth and cased as in oilwell drilling practice. If the well is drilled below the depth at which it is desired to fracture the formation, the well casing may then be perforated at the desired elevation. Conventional perforating means may be employed. A fluid is then pumped into the well to cause the application of pressure on the formation at the points of perforation of the casing to the extent necessary to cause a rupturing or parting of the formation. Though the type of formation will to an extent determine the pressure necessary to cause the fracture, it has been found that a surface-measured pressure of about 1.0 to 1.8 times the normal hydrostatic pressure of the depth to the point of fracture is sufficient to part the formation.

The initial parting of the formation may be detected by observing a substantial decline of the surface measured pressure at the input well. A second well is provided, communicating with the fracture, so that solvent pumped down one well flows through the fracture and out of the other well.

In accordance with this invention, after the initial parting of the formation, a substantial pressure is maintained along the line of fracture to maintain the fracture open and to support the overlying formation on the liquid or fluid in the fracture while at the same time passing a liquid suitable for dissolving the deposit along the line of fracture between two or more wells for a period of time sufficient to allow the formation of a substantial underground void. In this way a pair of wells may be brought into production more rapidly than if the formation is permitted to resettle, after the original fracturing

and slow solvent flow through the pores in the resettled formation is relied upon to establish free communication between the two wells.

The opening of the formation, according to the above-described method, will allow the rapid recovery of underground deposits by solution mining without the necessity of employing propping agents with their attendant disadvantages and without permitting the formation of innumerable settling cracks in the formation and without relying on slow seepage of a dissolving fluid through cracks in a resettled formation.

If the pressure brought to bear against the formation to fracture same is applied by hydraulic means, the use of positively displacement pumps is recommended as the source of the hydraulic pressure. Any fluid pressure may, of course, be used.

It is well to note that the pumps generating the pressure should have pumping capacity greater than that necessary to bring about the initial fracture. This extra pump capacity is necessary to compensate for liquor losses due to the replacement of the formation dissolved by the solvent, as well as to compensate for the liquid losses in the underground system, due to natural permeability previously existing or opened during the fracturing step.

A specific application of the process to the solution mining of trona is herein described but it will be understood that the principles of the invention are applicable to the mining of all other salt, sulfur and mineral deposits which can be removed in solution or liquified form.

The diagrammatic drawing shows two wells A and B drilled into a trona formation to a depth of about 1550 feet so they terminate just below the trona bed 10 and cased as indicated. The casings of wells A and B have been perforated at 13 substantially at the interface between the trona bed 10 and the underlying shale bed 11. An upper shale bed is indicated at 11a. An overburden approximately 1500 feet in depth lies above the shale bed 11a. A pumping means P is indicated at the head of well A for producing and maintaining pressure in the well A and on the formation and for circulating a dissolving liquid through the formation after a clear connection has been formed. Pumping means may be provided for either or both wells. Valves may be provided at the heads of wells A and B if desired. The fracture extending between wells A and B is indicated at C.

Following is an embodiment of this invention for the recovery of an underground deposit of trona.

Two wells, well A and well B, were drilled into the trona formation to a depth of about 1550 feet so that they were just below the trona bed. The ground distance between wells was approximately 400 feet. The thickness of the trona bed was about 12 feet. Wells A and B were cased and cemented in and well A was perforated at the interface between the trona bed and the underlying shale bed.

Pressure was applied to the perforated formation adjacent well A by pumping water down into well A to create a surface measured pressure of about 1600 p.s.i. gage. At this pressure the formation was parted as was noted by a rapid decline of the pressure to about 1020 p.s.i. with a further gradual decrease to about 920 p.s.i.

The pressure was maintained at about 920 p.s.i. or above to support the formation on the fracturing liquid while continuing to flow water along the line of fracture from well A to well B for a period of about 48 hours or until the pressure could be returned to the normal environmental pressure without causing closing of the formation. After this initial breaking in period, the pressure was returned to normal environmental pressures with continued unimpeded flow of solvent from one well to the other.

If after the initial fracturing of the formation the pressure had been relieved and returned to environmental pressure, the formation would have shut down and thus prevent, or greatly retarded, the flow of solvent from one well

to the other. However, by following the teachings of this invention and maintaining a floating pressure on the formation for a substantial time subsequent to the initial fracturing, an underground void is created along the line of the initial fracture which permits the solution mining of the formation without further maintenance of a formation separating pressure on the formation.

Pursuant to the requirements of the patent statutes, the principle of this invention has been explained and exemplified in a manner so that it can be readily practiced by those skilled in the art, such exemplification including what is considered to represent the best embodiment of the invention. However, it should be clearly understood that, within the scope of the appended claims, the invention may be practiced by those skilled in the art, and having the benefit of this disclosure, otherwise than as specifically described and exemplified herein.

That which is claimed as patentably novel is:

1. A method for creating an underground passage for solution mining of dense compacted underground deposits removable in liquid form comprising drilling a pair of wells into the said deposit formation, imposing a fluid pressure on the formation adjacent at least one of the wells sufficient to fracture the formation and spread the fracture to connect the two wells by pumping an aqueous solvent into one of said wells providing a pumping capacity greater than that necessary to bring about the initial fracture, and maintaining sufficient pressure on said aqueous solvent in the fractured formation to prevent resettling of the formation by pumping solvent into the formation through one of the wells under sufficient pressure to support the formation on the fracturing liquid while passing a liquid suitable for dissolving the formation rapidly along the line of fracture between the wells until a clear passage is produced between the wells to rapidly bring the wells into production and then returning the formation to its normal environmental pressure.

2. A method for creating an underground passage for solution mining of dense compacted salt deposits comprising: drilling a pair of wells into the salt formation, imposing a fluid pressure on the formation adjacent one of the wells sufficient to fracture the formation and connect the two wells by pumping an aqueous solvent into one of said wells maintaining sufficient pressure on said aqueous solvent in the fractured formation to support the overlying formation on the fracturing solvent and prevent resettling of the formation until the fracture has reached the other well and thereafter while continuing to maintain sufficient pressure in the fractured formation to prevent resettling of the formation and support the overlying formation on the fracturing solvent passing a liquid suitable for dissolving the formation along the line of fracture between the wells until a clear passage is produced between the wells.

3. A method for creating an underground passage for solution mining of dense compacted salt deposits comprising: drilling a pair of wells terminating below the salt formation, perforating the wells and formation at substantially the interface between the salt formation and the underlying earth formation, imposing a fluid pressure on the perforated formation adjacent one of the wells sufficient to fracture the formation and thereafter pumping fluid into the fracture under sufficient pressure to support the overlying formation on the fracturing fluid and spread the fracture to connect the two wells by pumping an aqueous solvent into one of said wells, maintaining sufficient pressure on said aqueous solvent in the fractured formation to prevent resettling of the formation while passing a liquid suitable for dissolving the formation along the line of fracture between the wells until a clear passage is produced between the wells.

4. A method for recovering an underground salt deposit by solution mining comprising: drilling an inlet

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and a producing well into the salt formation, imposing a fluid pressure of from about 1.0 to 1.8 times the hydrostatic pressure of the depth of the formation to the point of fracturing adjacent the interface of the salt formation and the underlying earth formation by pumping an aqueous solvent into one of said wells, so as to part the salt formation and after the initial parting of the formation, maintaining sufficient pressure on said solvent along the line of fracture to maintain a layer of fluid in the original fracture and keep the original fracture open and support the overlying formation on the fracturing fluid, and after interconnection of said wells continuing to maintain said pressure on said solvent and flowing solvent rapidly through the original fracture between said wells while permitting substantially unrestricted flow of solvent from the outlet well for a period of time sufficient to create a substantially sized void in the formation between said wells and after the above period, returning to normal environmental pressures and continuing to flow an aqueous solvent between the wells and recover dissolved salt.

5. A method for recovering an underground trona deposit by solution mining comprising: drilling an inlet and a producing well into the trona formation, imposing a fluid pressure at the interface between the trona deposit and the underlying earth formation adjacent the inlet well sufficient to fracture the formation and spread the fracture to connect the two wells by pumping an aqueous solvent into one of said wells, maintaining sufficient pressure on the fractured formation after said connection to prevent resettling of the formation while permitting unrestricted flow of solvent from the outlet well passing

said aqueous solvent rapidly along the line of fracture until a clear passage is produced between the wells, and recovering the trona rich solvent from the producing well and then returning the formation to normal environmental pressure.

6. A method for recovering an underground trona deposit by solution mining comprising: drilling an inlet and a producing well into the trona formation, imposing a ground surface fluid pressure of about 1600 p.s.i. on the formation at the interface of the trona and the underlying earth formation adjacent the inlet well so as to part the trona formation and connect the wells by pumping an aqueous solvent into said inlet well, maintaining a pressure of at least 900 p.s.i. along the line of fracture during the spread of the fracture from one well to another and while passing an aqueous solvent between the wells, maintaining said pressure and solvent flow for a period of at least 48 hours, until a clear passage is formed between the wells and after the above period relieving the pressure and returning same to normal environmental pressures and continuing to flow an aqueous solvent between the wells and recover dissolved trona therefrom.

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