Claims

1. A method for forming a closed loop wellbore into a formation for geothermal heat recovery, comprising:

   forming, during a drilling operation, a thermally conductive interface between said wellbore and said formation extending at least between an inlet well and an outlet well of said loop by introducing permeability damage to said wellbore with a chemical mechanism, wherein said interface is impermeable to fluids; and

   introducing a geothermal heat recovery working fluid into the wellbore while at least a portion of the wellbore is open hole and while maintaining the interface impermeable to fluids.

2. The method as set forth in claim 1 wherein said chemical mechanism comprises utilizing an alkali silicate based drilling fluid.

3. The method as set forth in claim 2, wherein said alkali silicate based drilling fluid includes at least one of potassium, sodium and sodium aluminosilicate.

4. The method as set forth in claim 2, wherein said drilling fluid contains between 0.3% and 9% alkali silicate by mass in water.

5. The method as set forth in claim 4, wherein said drilling fluid contains between 3% and 6% alkali silicate by mass in water.

6. The method as set forth in claim 4, wherein said drilling fluid has a pH not less than 10.5.

7. The method as set forth in any one of claims 1 to 6, further including the step of augmenting the sealing capacity and mechanical integrity associated with a formed interface in a further chemical unit operation; and

wherein the further chemical unit operation includes treating said interface with sodium aluminosilicate.

8. The method as set forth in claim 7, wherein said further chemical unit operation includes treating said interface with at least one of calcium chloride brine, acids, CO_2, surfactants and esters.

9. The method as set forth in claim 7, wherein said chemical unit operation comprises treating said formed interface with a compound capable of chemically bonding to said formed interface.

10. The method as set forth in claim 9, wherein said compound comprises exfoliated fly ash.

11. The method as set forth in claim 9, wherein said compound comprises at least one of surface-activated graphene, graphene oxide, carbon fibres and mixtures thereof.

12. The method as set forth in any one of claims 1 to 11, further including circulating a working fluid within said wellbore containing an interface maintenance additive for maintaining impermeability in use.

13. The method as set forth in claim 12, further including maintaining working fluid pressure within said wellbore at a pressure sufficient to maintain structural integrity of said wellbore when required.

14. The method as set forth in claim 12, wherein said working fluid comprises:

a nonlinear temperature enthalpy relationship within an interconnecting wellbore section between the inlet well and the outlet well at pressures greater than 10MPa and temperatures less than 180˚C to maximize the temperature differential and heat transfer between said fluid and the surrounding formation.

15. The method as set forth in claim 7, further including circulating a working fluid within said wellbore containing an interface maintenance additive for maintaining impermeability in use.

16. The method as set forth in claim 15, wherein said interface maintenance additive induces self healing of any permeability compromised areas of said interface.

17. The method as set forth in claim 12, wherein said interface maintenance additive induces self healing of any permeability compromised areas of said interface.

18. The method as set forth in claim 12, wherein said interface maintenance additive precipitates unreacted alkali-silicate remaining from the drilling process.

19. A method for forming a closed loop well with an inlet well and an outlet well in a formation for geothermal heat recovery, comprising:

forming, using a chemical mechanism, an interface between said wellbore and said formation while at least a portion of the wellbore is open hole, the interface impermeable to fluids and the wellbore extending between said inlet well and said outlet well; and

circulating a chemical composition within the formed wellbore capable of inducing precipitate formation with said interface to augment the sealing capacity and mechanical integrity of said interface.

20. The method as set forth in claim 19, further including the step of circulating a working fluid within the sealed wellbore containing an interface maintenance additive reactive with the formed interface for maintaining impermeability during circulation of said working fluid within said well.

21. A method for forming a closed loop well with an inlet well and an outlet well in a formation for geothermal heat recovery, comprising:

forming, using a chemical mechanism, an interface between said wellbore and said formation, the interface impermeable to fluids and the wellbore extending between said inlet well and said outlet well;

circulating a chemical composition within the formed wellbore capable of inducing precipitate formation with said interface to augment the sealing capacity and mechanical integrity of said interface; and

circulating a working fluid within the sealed wellbore while maintaining the interface impermeable to fluids and while at least a portion of the wellbore is open hole, the working fluid containing an interface maintenance additive reactive with the formed interface for maintaining said interface impermeable to fluids.

22. The method as set forth in any one of claims 19 to 21, wherein said well is a closed loop, continuous circuit with said interface extending at least between an inlet well and an outlet well of said loop.

23. The method as set forth in claim 20 or claim 21, wherein said working fluid a nonlinear temperature enthalpy relationship within an interconnecting wellbore section between said inlet well and said outlet well at pressures greater than 10MPa and temperatures less than 180˚C to maximize the temperature differential and heat transfer between said fluid and the surrounding formation.

24. The method as set forth in any one of claims 1 to 18, wherein said wellbore comprises at least one of a closed loop U shaped well with a spaced apart inlet well and outlet well and lateral well interconnecting said inlet well and said outlet well, L shaped well with a closed terminal end, tube in tube well, arrangement, grouped closed loop U shaped wells in spaced relation with an output well member in said group connected to an input well of

another group member, a closed loop U shaped well having a plurality of lateral wells commonly connected to a respective inlet well and outlet well, a plurality a closed loop U shaped well having a plurality of lateral wells commonly connected to a respective inlet well and outlet well arranged with lateral wells of said plurality arranged with said laterals at least partially interdigitated for thermal contact and combinations thereof.

25. The method as set forth in claim 24, further including the step of incorporating a device for storing, using and/or converting thermal energy from a working fluid circulating in said closed loop.

26. The method as set forth in any one of claims 19 to 23, wherein said wellbore comprises at least one of a closed loop U shaped well with a spaced apart inlet well and outlet well and lateral well interconnecting said inlet well and said outlet well, L shaped well with a closed terminal end, tube in tube well arrangement, grouped closed loop U shaped wells in spaced relation with an output well member in said group connected to an input well of another group member, a closed loop U shaped well having a plurality of lateral wells commonly connected to a respective inlet well and outlet well, a plurality a closed loop U shaped well having a plurality of lateral wells commonly connected to a respective inlet well and outlet well arranged with lateral wells of said plurality arranged with said laterals at least partially interdigitated for thermal contact and combinations thereof.

27. The method as set forth in claim 26, further including the step of incorporating a device for storing, using and/or converting thermal energy from said working fluid circulating in said closed loop.

28. The method as set forth in claim 1 or claim 22, wherein drilling said closed-loop well induces additional fractures or fissures within said formation which are subsequently sealed.

29. A method for remediating a well including at least one of fractured sections created by drilling or fracturing techniques, unconsolidated rock and sand within an earth formation, comprising:

treating said well and pore space of at least one of said fractured sections, unconsolidated rock and sand by the addition of a preliminary chemical composition capable of forming a precipitated fluid impermeable interface at said sections, wherein treating said well comprises treating said well while at least a portion of the well is open hole.

30. The method as set forth in claim 29, further including the step of treating said interface with a second chemical composition for precipitating any unreacted preliminary chemical composition to further seal said interface.

31. The method as set forth in claim 29 or claim 30, wherein said preliminary chemical composition is an alkali silicate fluid.

32. The method as set forth in claim 31, wherein said alkali silicate fluid includes at least one of potassium, sodium and sodium aluminosilicate.

33. The method as set forth in any one of claims 30 to 32, wherein said second chemical composition includes at least one of calcium chloride brine, acids, CO_2, surfactants and esters.

34. A method for remediating a well having pore space and including at least one of fractured sections created by drilling or fracturing techniques, unconsolidated rock and sand within an earth formation, comprising:

treating said well and said pore space of at least one of said fractured sections, unconsolidated rock and sand by the addition of a preliminary chemical composition capable of forming a precipitated fluid impermeable interface at said sections, wherein treating said well comprises treating said well while at least a portion of the well is open hole;

treating a formed interface with a second chemical composition for precipitating any unreacted preliminary chemical composition to further seal said interface.

35. The method as set forth in claim 34, wherein said preliminary chemical composition is an alkali silicate fluid.

36. The method as set forth in claim 31, wherein said alkali silicate fluid includes at least one of potassium, sodium and sodium aluminosilicate.

37. A method for remediating a well including at least one of fractured sections created by drilling or fracturing techniques, unconsolidated rock and sand within an earth formation, comprising:

treating said well and pore space of at least one of said fractured sections, unconsolidated rock and sand by the addition of an alkali silicate composition capable of forming a precipitated fluid impermeable interface at said sections; and

treating said interface with a second chemical composition for precipitating any unreacted alkali silicate composition to further seal said interface.

38. A method for converting a geothermal well having at least one of fractures, unconsolidated rock and sand, an inlet well and an outlet well in fluid communication, to a sealed closed loop geothermal well, comprising:

introducing a preliminary chemical composition capable of forming a precipitated impervious and thermally conductive interface between said inlet well and said outlet well and in at least one of said fractures, unconsolidated rock and sand whereby a closed sealed well loop is formed with the inlet well, the outlet well, and the area there between.

39. The method as set forth in claim 38, further including the step of treating said interface with a second chemical composition for precipitating any unreacted preliminary chemical composition to further seal said interface.

40. The method as set forth in claim 38 or claim 39, further including the step of circulating a working fluid within said closed loop capable of reacting with said interface to maintain impermeability during circulation of said working fluid.

41. The method as set forth in any one of claims 38 to 40, further including the step of continuously circulating working fluid within said closed loop.

42. The method as set forth in claim 40 or claim 41, further including the step of incorporating a device for storing, using and/or converting thermal energy from said working fluid circulating in said closed loop.

43. The method as set forth in any one of claims 38 to 42, including drilling from said inlet well to said outlet well to form a wellbore loop continuous from said inlet well to said outlet well.

44. A method of forming a closed loop geothermal well having an inlet well and an outlet well, comprising:

providing a drilling fluid capable of sealing an open hole wellbore between said inlet well and said outlet well; and

sealing while drilling said open hole wellbore to form a fluid impermeable interface between the interior of the wellbore and the surrounding formation.

45. The method as set forth in claim 44, further including inducing a second sealing operation at said interface.

46. The method as set forth in claims 44 or 45, further including inducing a third sealing operation at said interface.

47. The method as set forth in any one of claims 1, 19, 21, 29, 34, 37, 38 or 44 wherein said interface has a permeability of 0.197mD or less.