CLAIMS:

1. A system for recovering metal and elemental Sulfur from a non-aqueous feed stream, comprising:

a first electrolytic cell comprising:

a first anolyte compartment configured to hold an anolyte, wherein the anolyte comprises at least one of an alkali metal sulfide and an alkali metal polysulfide, a polar organic solvent that dissolves elemental Sulfur and dissolves at least one of the alkali metal sulfide and the alkali metal polysulfide, the anolyte further comprising at least one of a heavy metal, a heavy metal compound, and a heavy metal ion;

a first anode positioned within the first anolyte compartment in communication with the anolyte;

a first catholyte compartment configured to hold a catholyte, wherein the catholyte comprises an alkali ion-conductive liquid;

a first cathode positioned within the first catholyte compartment in communication with the catholyte;

a first separator positioned between the first anolyte compartment and the first catholyte compartment, the first separator in communication with the anolyte of the first anolyte compartment and the catholyte of the first catholyte compartment, the first separator configured to non-selectively transport cations; and.

a first power source in electrical communication with the first anode and the first cathode, wherein the first power source is configured to apply a voltage to the first electrolytic cell that is sufficient to reduce at least one heavy metal ion to heavy metal.

2. The system of claim 1, further comprising a second electrolytic cell in fluid. communication with the first electrolytic cell, wherein the second electrolytic cell comprises:

a second anolyte compartment configured to hold a anolyte, wherein the anolyte comprises at least one of an alkali metal sulfide and an alkali metal polysulfide, a polar organic solvent that dissolves elemental Sulfur and dissolves at least one of the alkali metal sulfide and the

alkali metal polysulfide, the anolyte of the second compartment further comprising at least a portion of anolyte removed from the first anolyte compartment of the first electrolytic cell;

a second anode positioned within the second anolyte compartment in communication with the anolyte;

a second catholyte compartment configured to hold a catholyte, wherein the catholyte comprises an alkali ion-conductive liquid;

a second cathode positioned within the second catholyte compartment in communication with the catholyte;

a second separator positioned between the second anolyte compartment and the second catholyte compartment, the second separator in communication with the anolyte of the second anolyte compartment and the catholyte of the second catholyte compartment, wherein the second separator is an alkali-ion selective membrane configured to selectively transport alkali ions; and

a second power source in electrical communication with the second anode and the second cathode, wherein the second power source is configured to apply a voltage to the second electrolytic cell that is greater than the open circuit potential of the second electrolytic cell.

3. The system of any preceding claim, wherein the anolyte further comprises elemental Sulfur.

4. The system of any preceding claim, wherein the first separator comprises at least one of a cation exchange membrane and a microporous membrane.

5. The system of any preceding, further comprising a heater, and wherein at least one of the first electrolytic cell and the second electrolytic cell operates at temperature of below the melting point of alkali metal; and/or wherein at least one of the first electrolytic cell and the second electrolytic cell operates at temperature ranging from 100° C to 160° C; and/or wherein the temperature ranges from 120° C to 150°C.

6. The system of any preceding claim, wherein the ion-conductive liquid comprises at least one of a catholyte solvent containing alkali metal ions and molten alkali metal.

7. The system of any preceding claim, wherein the first anolyte compartment comprises a turbulence promotor.

8. The system of any preceding claim, further comprising a cooling apparatus in communication with at least one of the first anolyte compartment and the second anolyte compartment to facilitate the removal of elemental Sulfur from the anolyte compartment.

9. The system of claim 2, further comprising a third electrolytic cell in fluid communication with the second electrolytic cell, the third electrolytic cell comprising:

a third anolyte compartment configured to hold an anolyte, wherein the anolyte comprises at least one of an alkali metal sulfide and an alkali metal polysulfide, a polar organic solvent that dissolves elemental Sulfur and dissolves at least one of the alkali metal sulfide and the alkali metal polysulfide, the anolyte of the third anolyte compartment further comprising at least a portion of anolyte removed from the second anolyte compartment of the second electrolytic cell;

a third anode positioned within the third anolyte compartment in communication with the anolyte;

a third catholyte compartment configured to hold a catholyte, wherein the catholyte comprises an alkali ion-conductive liquid;

a third cathode positioned within the third catholyte compartment in communication with the catholyte;

a third separator positioned between the third anolyte compartment and the third catholyte compartment, the third separator in communication with the anolyte of the third anolyte compartment and the catholyte of the third catholyte compartment, wherein the third separator is an alkali-ion selective membrane configured to selectively transport alkali ions; and

a third power source in electrical communication with the third anode and the third cathode, wherein the third power source is configured to apply a voltage to the third electrolytic cell that is sufficient to oxidize sulfide ions to form elemental Sulfur.

10. The system of claim 1, wherein a voltage is applied to the first electrolytic cell sufficient to reduce at least one alkali metal ion in the first electrolytic cell to alkali metal.

11. The system of claim 1 or 2, wherein the first power source is configured to apply a voltage to the first electrolytic cell sufficient to increase the oxidation state of at least one sulfide ion in the first electrolytic cell.

12. The system of claim 1, 2, or 3 wherein the alkali metal comprises sodium and the ratio of sodium to Sulfur in the first anolyte compartment is such that the open circuit potential of the first electrolytic cell is greater than 2.3V.

13. The system of claim 1, 2, or 3 wherein the alkali metal comprises lithium and the ratio of lithium to Sulfur in the first anolyte compartment is such that the open circuit potential of the first electrolytic cell is greater than 2.63V.

14. The system of claim 2, wherein a voltage applied to the first electrolytic cell is at least 0.2V below the open cell potential of the first electrochemical cell and wherein a voltage applied to the second electrolytic cell is sufficient to oxidize sulfide ions in the second anolyte compartment to form elemental Sulfur.

15. The system of claim 9, wherein a voltage applied to the first electrolytic cell is below the open cell potential of the first electrochemical cell and wherein a voltage applied to the second electrolytic cell is sufficient to increase the oxidation state of at least one sulfide ion in the second electrolytic cell, but insufficient to form elemental Sulfur, and wherein a voltage applied to the third electrolytic cell is sufficient to form elemental Sulfur in the third electrolytic cell.

16. The system of claim 15, wherein the alkali metal in at least one of the alkali metal sulfide and alkali metal polysulfide in the second anolyte compartment comprises sodium, and wherein the ratio of sodium to Sulfur in the second anolyte compartment is such that the open circuit potential of the second electrolytic cell is greater than or equal to 2.3V

17. The system of claim 15, wherein the alkali metal in at least one of the alkali metal sulfide and alkali metal polysulfide in the second anolyte compartment comprises lithium, and wherein the ratio of lithium to Sulky in the second anolyte compartment is such that the open circuit potential of the second electrolytic cell is greater than 2.63V.

18. A method for recovering metal and Sulfur from a feed stream; comprising:

providing a first electrolytic cell comprising:

a first anolyte compartment configured to hold an anolyte;

a first anode positioned within the first anolyte compartment in communication with the anolyte;

a first catholyte compartment configured to hold a catholyte, wherein the catholyte comprises an alkali ion-conductive liquid;

a first cathode positioned within the first catholyte compartment in communication with the catholyte;

a first separator positioned between the first anolyte compartment and the first catholyte compartment, the first separator in communication with the anolyte of the first compartment and the catholyte of the first compartment, the first separator configured to non-selectively transport cations; and

a first power source in electrical communication with the first anode and the first cathode;

introducing an anolyte into the first anolyte compartment of the first electrolytic cell, wherein the anolyte comprises at least one of an alkali metal sulfide and an alkali metal polysulfide, a polar organic solvent that dissolves at least one of the alkali metal sulfide, alkali metal polysulfide, and that dissolves elemental sulfur, the anolyte further comprising at least one of a heavy metal, a heavy metal compound, and a heavy metal ion;

introducing a catholyte into the first catholyte compartment of the first electrolytic cell, wherein the catholyte comprises an alkali ion-conductive liquid;

applying a voltage to the first electrolytic cell that is sufficient to reduce at least one heavy metal ion to heavy metal;

oxidizing at least one sulfide ion in the anolyte of the first anolyte compartment of the first electrolytic cell;

moving cations to pass through the first separator positioned between, and in communication with the first anolyte compartment and the first catholyte compartment, the cations passing from the first anolyte compartment to the first catholyte compartment; and

reducing at least one of said cations in the catholyte compartment to form metal.

19. The method of claim 18, further comprising:

providing a second electrolytic cell in fluid communication with the first electrolytic cell, the second electrolytic cell comprising:

a second anolyte compartment configured to hold a anolyte;

a second anode positioned within the second anolyte compartment in communication with the anolyte;

a second catholyte compartment configured to hold a catholyte;

a second cathode positioned within the second catholyte compartment in communication with the catholyte;

a second separator positioned between the second anolyte compartment and the second catholyte compartment, the second separator in communication with the anolyte of the second anolyte compartment and the catholyte of the second catholyte compartment, wherein the second separator is an alkali-ion selective membrane configured to selectively transport alkali ions; and

a second power source in electrical communication with the second anode and the second cathode;

introducing an anolyte into the second anolyte compartment of the second electrolytic cell, wherein the anolyte comprises at least one of an alkali metal sulfide and an alkali metal polysulfide, a polar organic solvent that dissolves at least one of the alkali metal sulfide, alkali metal polysulfide, and that dissolves elemental sulfur, and wherein introducing an anolyte into the second anolyte compartment of the second electrolytic cell comprises introducing at least a portion of anolyte removed from the first anolyte compartment of the first electrolytic cell into the second anolyte compartment of the second electrolytic cell;

introducing a catholyte into the second catholyte compartment of the second electrolytic cell, wherein the catholyte comprises an alkali ion-conductive liquid;

applying a voltage to the second electrolytic cell that is greater than the open circuit potential of the second electrolytic cell;

causing alkali metal cations to pass through the second separator of the second electrolytic cell from the second anolyte compartment to the second catholyte compartment;

reducing at least one metal cation in the second catholyte compartment to form an alkali metal;

increasing the oxidation state of at least one sulfide ion in the second anolyte compartment of the second electrolytic cell.

20. The method of claim 18 or 19 further comprising, wherein the first power source is configured to apply a voltage to the first electrolytic cell that is insufficient to reduce alkali metal ions in the first electrolytic cell to alkali metal.

21. The method of claim 20, wherein the alkali metal in at least one of the alkali metal sulfide and alkali metal polysulfide in the second anolyte compartment comprises sodium, and the ratio of sodium to Sulfur in the second anolyte compartment is such that the open circuit potential of the second electrolytic cell is greater than or equal to 2.3V.

22. The method of claim 20, wherein the alkali metal in at least one of the alkali metal sulfide and alkali metal polysulfide in the second anolyte compartment comprises lithium, and the ratio of lithium to Sulfur in the second anolyte compartment is such that the open circuit potential of the second electrolytic cell is greater than or equal to 2.63V.