

CLAIMS

The invention claimed is:

1. A radar system for detecting ferrous and non-ferrous metals in underwater environments, comprising:

at least one towing vessel configured to traverse a target area;

an antenna system including at least one signal generator, at least one transmitter (Tx) antenna, at least one receiver (Rx) antenna, and at least one signal processor;

a graphical user interface (GUI);

wherein the at least one signal generator is operable to emit at least one transmission signal to the target area through the at least one Tx antenna,

wherein the at least one transmission signal is an extremely low frequency (ELF) signal;

wherein the at least one transmission signal is a continuous-wave signal;

wherein the at least one Rx antenna is operable to receive at least one return signal from the target area, wherein the at least one return signal is based on the at least one transmission signal;

wherein the at least one signal processor is operable to detect a plurality of target objects in the target area based on the at least one return signal, and wherein the plurality of target objects includes ferrous and/or non-ferrous metals; and

wherein the GUI is operable to map and display the plurality of target objects in the target area.
2. The system of claim 1, wherein the underwater environments are saltwater environments and/or brackish environments.
3. The system of claim 1, wherein the at least one towing vessel includes a floatation device, and wherein the antenna system is connected to the floatation device.

4. The system of claim 1, wherein the antenna system includes a plurality of Rx antennas for each of the at least one Tx antennas.
5. The system of claim 1, wherein the at least one Tx antenna and the at least one Rx antenna are cross-polarized.
6. The system of claim 1, wherein the at least one signal generator is operable to generate a plurality of transmission signals, and wherein the plurality of transmission signals have different frequencies.
7. The system of claim 1, wherein the at least one signal processor is operable to identify constructive interference zones and destructive interference zones in the target area based on the antenna system and the at least one transmission signal.
8. The system of claim 1, wherein the at least one signal processor uses a baseline signal to normalize the at least one return signal.
9. The system of claim 1, wherein the antenna system is operable to adjust transmission power levels of at least one additional transmission signal emitted to the target area and/or return power levels of at least one additional return signal from the target area after receiving the at least one return signal.
10. The system of claim 1, wherein the at least one signal processor is operable to distinguish between different types of metal composing the plurality of target objects.
11. The system of claim 1, wherein the at least one signal processor is operable to detect and identify the plurality of target objects in real-time or near real-time.
12. A radar system for detecting ferrous and non-ferrous metals in underwater environments, comprising:
 - at least one towing vessel configured to traverse a target area;

an antenna system including at least one signal generator, at least one transmitter (Tx) antenna, at least one receiver (Rx) antenna, and at least one signal processor;

a geolocation system; and

a graphical user interface (GUI);

wherein the at least one signal generator is operable to emit at least one transmission signal to the target area through the at least one Tx antenna,

wherein the at least one transmission signal is an extremely low frequency (ELF) signal,

wherein the at least one transmission signal is a continuous-wave signal;

wherein the at least one Rx antenna is operable to receive at least one return signal from the target area, wherein the at least one return signal is based on the at least one transmission signal;

wherein the at least one signal processor is operable to detect a plurality of target objects in the target area based on the at least one return signal, and wherein the plurality of target objects includes ferrous and/or non-ferrous metals;

wherein the at least one signal processor is operable to determine a relative geolocation and/or an absolute geolocation of the plurality of target objects based on the at least one return signal and the geolocation system; and

wherein the GUI is operable to map and display the plurality of target objects in the target area.

13. The system of claim 12, wherein the geolocation system includes a plurality of signal reflectors in the underwater environment, and wherein the relative geolocation of the plurality of target objects is based on the plurality of signal reflectors.

14. The system of claim 12, wherein the geolocation system is located on a floatation device, and wherein the floatation device is connected to the at least one towing vessel.
15. A method for detecting ferrous and non-ferrous metals in underwater environments, comprising:
- at least one towing vessel traversing a target area in a repeating pattern;
 - at least one signal generator emitting at least one transmission signal to the target area through at least one transmitter (Tx) antenna;
 - at least one receiver (Rx) antenna receiving at least one return signal from the target area;
 - at least one signal processor processing the at least one return signal to detect a plurality of target objects in the target area; and
 - a graphical user interface (GUI) mapping and displaying the plurality of target objects in the target area;
- wherein the at least one transmission signal is an extremely low frequency (ELF) signal;
- wherein the at least one transmission signal is a continuous-wave signal; and
- wherein the plurality of target objects includes ferrous and/or non-ferrous metals.
16. The method of claim 15, wherein the towing vessel traverses at least one portion of the target area multiple times.
17. The method of claim 15, wherein the at least one signal generator emitting at least one transmission signal to the target area through at least one Tx antenna includes the at least one signal generator emitting a plurality of transmission signals, wherein the plurality of transmission signals have different frequencies.
18. The method of claim 15, further comprising the at least one signal generator adjusting transmission power levels of at least one additional transmission signal emitted to the target area

and/or return power levels of at least one additional return signal from the target area after receiving the at least one return signal.

19. The method of claim 15, further comprising the at least one signal processor identifying constructive interference zones and destructive interference zones in the target area based on the at least one transmission signal, the at least one Tx antenna, and the at least one Rx antenna.

20. The method of claim 15, wherein the at least one signal processor processing the at least one return signal to detect a plurality of target objects in the target area includes the at least one signal processor distinguishing between different types of metal composing the plurality of target objects.