SUMMARY OF INVENTION

[0004a]

According to a first aspect of the present invention, there is provided a downhole measurement apparatus comprising: a longitudinal body including a logging tool, the logging tool further comprising: an outsert containing a detector, the outsert disposed in an outer pocket of the body and coupled therein; and a logging source axially spaced from the detector, wherein the axial space between the logging source and the detector is calibrated via a source holder coupled to the outsert to form a sensor package; and a stabilizer coupled to the body adjacent the logging tool to deflect the logging tool and the outsert toward an earth formation.

[0004b]

According to a second aspect of the present invention, there is provided a downhole measurement apparatus comprising: a longitudinal body including a nuclear logging tool, the logging tool further comprising an outsert containing a detector, the outsert disposed in an outer pocket of the body and coupled therein; and a stabilizer coupled to the body adjacent the nuclear logging tool to deflect the logging tool and the outsert toward an earth formation; wherein the outsert is a pressure housing sealing the detector from the exterior of the body, and the pressure-sealed outsert is removable from the pocket; wherein the coupling between the outsert and the body includes at least one of a hydrostatic locking screw, a spacer block coupled between the outsert and the body pocket, a finger retention mechanism, an interlocking wedge mechanism, and an interconnect junction coupling the outsert to a second outsert in the pocket.

[0004c]

According to a third aspect of the present invention, there is provided a downhole measurement apparatus comprising: a longitudinal drill collar body including a nuclear logging tool, the logging tool further comprising: a nuclear source holder containing a nuclear source; and an outsert containing a detector, the outsert coupled in an outer pocket of the drill collar body, wherein the nuclear source is axially spaced a calibrated distance from the detector; and a stabilizer coupled to the body adjacent the nuclear logging tool; wherein the nuclear source holder and the outsert are exposed to an exterior of the drill collar body to dispose the nuclear source and the detector adjacent an outer diameter of the drill collar body.

[0004d] According to a fourth aspect of the present invention, there is provided a downhole measurement apparatus comprising: a longitudinal drill collar body having an outer pocket and an outer diameter; an outsert coupled into and exposed through the outer pocket to position the outer surface of the outsert adjacent to the outer diameter of the drill collar body, the outsert containing a logging sensor; a nuclear source holder disposed in the drill collar body containing a nuclear source axially spaced a calibrated distance from the logging sensor; and a stabilizer coupled to the body adjacent the nuclear logging tool to increase proximity of the outer surface of the outsert to an earth formation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] For a detailed description of exemplary embodiments of the disclosure, reference will now be made to the accompanying drawings in which:

[0006] Figure 1 shows a schematic side view of an exemplary drill string and bottom hole assembly including a MWD/LWD drill collar assembly;

[0007] Figure 2 is a schematic view, partly in cross-section, of a sensor tool conveyed by wireline;

[0008] Figure 3 is a schematic view, partly in cross-section, of a sensor tool disposed on a wired drill pipe connected to a telemetry network;

[0009] Figure 4 is a cross-section view of a section of wired drill pipe;

[0010] Figure 5 shows a perspective view, in partial phantom, of an exemplary nuclear measurement tool in accordance with principles disclosed herein;

[0011] Figure 6 shows a top view of the tool of Figure 5;

[0012] Figure 7 shows a cross-section view of the tool of Figure 6 taken at the section 4-4;

[0013] Figure 8 shows a cross-section view of the tool of Figure 6 taken at the section 5-5;

[0014] Figure 9 shows a perspective view of the nuclear source holder of the tool of Figures 5, 6 and 8;

[0015] Figure 10 shows another perspective view of the source holder of Figure 9;

[0016] Figure 11 shows another perspective view, in cross-section, of the source holder of Figure 9;

[0017] Figures 12-14 are perspective views of an alternative embodiment of a nuclear measurement tool including an integrated source holder portion in accordance with principles disclosed herein;

[0018] Figure 15 is a perspective view of the nuclear measurement tool of Figures 12-14 including an alternative off-center stabilizer;

[0019] Figure 16 is a perspective view of finger retention mechanisms for the outserts of the previously shown nuclear measurement tools;

[0020] Figure 17 shows a perspective view of an embodiment of a retained sensor package having a source emitting window and a detector window;

[0021] Figure 18 shows a perspective view of a detector window of an embodiment of a detector window assembly in accordance with principles disclosed herein;

[0022] Figure 19 shows a perspective view of a ring of the detector window assembly;

[0023] Figure 20 shows a perspective view of the assembled detector window including the components of Figures 18 and 19;

What is claimed is:

1. A downhole measurement apparatus comprising:

a longitudinal body including a logging tool, the logging tool further comprising:

an outsert containing a detector, the outsert disposed in an outer pocket of the body and coupled therein; and

a logging source axially spaced from the detector, wherein the axial space between the logging source and the detector is calibrated via a source holder coupled to the outsert to form a sensor package; and

a stabilizer coupled to the body adjacent the logging tool to deflect the logging tool and the outsert toward an earth formation.

2. The apparatus of claim 1 wherein the source holder includes interlocking tabs coupled to the body.

3. The apparatus of claim 1 further comprising a hydrostatic locking screw coupling the outsert to the body.

4. The apparatus of claim 1 further comprising a spacer block coupled between the outsert and the body pocket.

5. The apparatus of claim 1 further comprising a finger retention mechanism coupling the outsert in the pocket.

6. The apparatus of claim 1 further comprising an interlocking wedge mechanism coupling the outsert in the pocket.

7. The apparatus of claim 1 further comprising an interconnect junction coupling the outsert to a second outsert in the pocket.

8. The apparatus of claim 1 wherein the outsert is a pressure housing sealing the detector form an exterior of the body.

9. The apparatus of claim 8 wherein the pressure-sealed outsert is removable from the pocket.

10. A downhole measurement apparatus comprising:

a longitudinal body including a nuclear logging tool, the logging tool further comprising an outsert containing a detector, the outsert disposed in an outer pocket of the body and coupled therein; and

a stabilizer coupled to the body adjacent the nuclear logging tool to deflect the logging tool and the outsert toward an earth formation;

wherein the outsert is a pressure housing sealing the detector from the exterior of the body, and the pressure-sealed outsert is removable from the pocket;

wherein the coupling between the outsert and the body includes at least one of a hydrostatic locking screw, a spacer block coupled between the outsert and the body pocket, a finger retention mechanism, an interlocking wedge mechanism, and an interconnect junction coupling the outsert to a second outsert in the pocket.

11. A downhole measurement apparatus comprising:

a longitudinal drill collar body including a nuclear logging tool, the logging tool further comprising:

a nuclear source holder containing a nuclear source; and

an outsert containing a detector, the outsert coupled in an outer pocket of the drill collar body, wherein the nuclear source is axially spaced a calibrated distance from the detector; and

a stabilizer coupled to the body adjacent the nuclear logging tool;

wherein the nuclear source holder and the outsert are exposed to an exterior of the drill collar body to dispose the nuclear source and the detector adjacent an outer diameter of the drill collar body.

12. The apparatus of claim 11 wherein the stabilizer deflects the logging tool toward an earth formation to position the nuclear source and the detector in close proximity to the earth formation.

13. The apparatus of claim 11 wherein the nuclear source holder is coupled to the outsert to form a sensor package.

14. The apparatus of claim 11 wherein the nuclear source holder is an integrated portion of the drill collar body.

15. A downhole measurement apparatus comprising:

a longitudinal drill collar body having an outer pocket and an outer diameter;

an outsert coupled into and exposed through the outer pocket to position the outer surface of the outsert adjacent to the outer diameter of the drill collar body, the outsert containing a logging sensor;

a nuclear source holder disposed in the drill collar body containing a nuclear source axially spaced a calibrated distance from the logging sensor; and

a stabilizer coupled to the body adjacent the nuclear logging tool to increase proximity of the outer surface of the outsert to an earth formation.

16. The apparatus of claim 15 wherein the stabilizer is an off-center stabilizer including a radially greatest blade opposite the outsert on the drill collar body.

17. The apparatus of claim 15 wherein the outsert is removable and interchangeable between multiple drill collar bodies.

18. The apparatus of claim 15 wherein the nuclear source holder is coupled to the outsert to form a sensor package.

19. The apparatus of claim 15 wherein the nuclear source holder is an integrated portion of the drill collar body.

20. The apparatus of claim 15 further comprising an outsert retention mechanism including a hydrostatic locking screw, a spacer block, a finger retention mechanism, an interlocking wedge mechanism, an interconnect junction, or a combination thereof.