CLAIMS:

1. A wireless detonator assembly for use in connection with a blasting machine that transmits at least one wireless command signal to the wireless detonator assembly, the wireless detonator assembly comprising:

a detonator comprising a shell and a base charge for actuation;

command signal receiving and processing module for receiving and processing said at least one wireless command signal from said blasting machine;

at least one state sensor to sense at least one environmental condition in an immediate vicinity of the wireless detonator assembly; and

an activation / deactivation module to render the wireless detonator assembly capable of actuation in response to a command signal to FIRE when said at least one state sensor senses that the at least one environmental condition falls within pre-determined parameters suitable for blasting, the wireless detonator assembly otherwise maintaining a safe mode incapable of receiving and / or responding to a command signal to FIRE.

2. The wireless detonator assembly of claim 1, wherein the command signal receiving and processing module comprises an RF receiver.

3. The wireless detonator assembly of claim 1, wherein the at least one state sensor senses at least one environmental condition of the detonator assembly , such that failure to detect an appropriate environmental condition is indicative of the absence of the wireless detonator assembly from, or improper placement of the wireless detonator at, the blast site.

4. The wireless detonator assembly of claim 1, wherein the at least one state sensor senses for at least one environmental condition that is normally associated with conditions down a borehole in rock to be blasted.

5. The wireless detonator assembly of claim 1, wherein the at least one state sensor is located within said detonator shell.

6. The wireless detonator assembly of claim 1, further comprising a top-box remote from the detonator shell and associated components, to remain at or above ground-level when the wireless detonator assembly is placed at a blast site.

7. The wireless detonator assembly of claim 1, further comprising a container or housing for containing or housing at least the components of the assembly other than the detonator, with a wired or wireless link between the other components and the detonator.

8. The wireless detonator assembly of claim 1, further comprising a firing circuit associated with the base charge, said base charge actuatable through application of a current through the firing circuit, said activation / deactivation module comprising a switch to open the firing circuit when said at least one state sensor senses that the at least one environmental conditions falls outside of said pre-determined parameters suitable for blasting, thereby to prevent actuation of the base charge even upon receipt by the command signal receiving and processing module of a command signal to FIRE.

9. The wireless detonator assembly of claim 1, further comprising a charge storage device such as a capacitor together with a firing circuit, so that upon receipt by the command signal receiving and processing module of a command signal to FIRE, the capacitor is connected via the firing circuit to the base charge, to cause a current in the firing circuit sufficient to actuate the base charge, said activation / deactivation module comprising discharge means to selectively bleed charge away from the charge storage device as long as at least one state sensor senses environmental conditions that fall outside said pre-determined parameters suitable for blasting.

10. The wireless detonator assembly of claim 1, further comprising a clock to count down a deployment window, within which the at least one state sensor is inactive, or within which the wireless detonator is non-responsive to the at least

one state sensor, after which the at least one state sensor senses the at least one environmental condition in the immediate vicinity of the detonator assembly, and the detonator assembly is responsive to the at least one environmental condition.

11. The wireless detonator assembly of claim 1, further comprising a clock to count-down a time-window for a blasting event, wherein the state sensors are active to sense the at least one environmental condition of the immediate vicinity of the assembly only within said time-window.

12. The wireless detonator assembly of claim 1, wherein each state sensor senses at least one environmental condition selected from: temperature, light, motion, acceleration, vibration, humidity, density, and pressure.

13. The wireless detonator assembly of claim 1, further comprising wireless signal transmission means, for transmitting to an associated blasting machine, hand-held device or logger, data corresponding to the environment condition in its immediate vicinity at the blast site.

14. A method of blasting rock pre-drilled with boreholes, the method comprising the steps of:

1) assigning to each borehole at least one wireless detonator assembly of claim 1;

2) optionally using a hand-held device or logger to communicate with each assigned assembly to read data from and / or program data into each assembly;

3) connecting each assembly to an explosive material to form a primer;

4) placing each primer into the borehole;

5) loading explosive into each borehole;

6) optionally stemming each borehole;

7) transmitting wireless command signals to control and FIRE each detonator;

wherein at any time the method further comprises: sensing at least one environmental condition in an immediate vicinity of each wireless detonator

assembly, each assembly rendered incapable of actuation at any time if the sensed environmental condition is or becomes outside of predetermined parameters for blasting.

15. The method of claim 14, wherein in step 7) the command signals are RF signals.

16. The method of claim 14, wherein the sensing of the at least one environmental condition is specific to environmental conditions associated with the blast site, such that failure to detect favourable environmental conditions for blasting is indicative of the absence of the wireless detonator assembly from, or improper placement of the wireless detonator assembly at, the blast site.

17. The method of claim 14, wherein the sensing of the at least one environmental condition is specific to environmental conditions normally expected within a borehole, whereby when sensing of the at least one environmental condition that is or becomes outside of the predetermined parameters for a particular wireless detonator assembly is indicative that the wireless detonator assembly is improperly positioned in, or not positioned in, a borehole.

18. The method of claim 14, wherein each wireless detonator assembly further comprises a top-box remote from the detonator shell and associated components, positioned at or above ground-level, wherein the step of receiving wireless command signals occurs at or above ground level at each borehole.

19. The method of claim 14, wherein at least step 1) and optionally further steps, are conducted within a deployment window, within which the sensing does not occur or each wireless detonator assembly is non-responsive to such sensing, after which the sensing occurs, and each wireless detonator assembly is responsive to its environmental conditions.

20. The method of claim 14, wherein the sensing senses at least one environmental condition selected from: temperature, light, motion, acceleration, vibration, humidity, density, and pressure.

21. The method of claim 14, further comprising the step of: transmitting from each wireless detonator assembly to an associated blasting machine, hand-held device or logger, data corresponding to the environment condition(s) in the immediate vicinity of each wireless detonator assembly at the blast site.

22. The method of claim 14, further comprising a step of assigning a time-window to the blast, each wireless detonator assembly comprising a clock for counting-down the time-window, wherein the step of sensing only continues or occurs within the time window.

23. A wireless electronic primer for use in connection with a blasting machine, said blasting machine controlling said wireless electronic primer via at least one wireless command signal, the wireless electronic primer comprising:

the wireless detonator assembly of claim 1;

an explosive charge in operative association with said detonator, such that actuation of said base charge causes actuation of said explosive charge;

said command signal receiving and processing module in signal communication with said detonator such that upon receipt of a command signal to FIRE by said command signal receiving and processing module said base charge and thus said explosive charge are actuated, providing said at least one state sensor senses environmental conditions that fall within pre-determined parameters suitable for blasting.

CLAIMS:

1. A wireless detonator assembly (10) for use in connection with a blasting machine that transmits at least one wireless command signal to the wireless detonator assembly, the wireless detonator assembly comprising:

a detonator (12) comprising a shell and a base charge for actuation;

command signal receiving and processing module (40) for receiving and processing said at least one wireless command signal from said blasting machine;

at least one state sensor (15) to sense at least one environmental condition in an immediate vicinity of the wireless detonator assembly;

an activation / deactivation module (42) to render the wireless detonator assembly capable of actuation in response to a command signal to FIRE when said at least one state sensor senses that the at least one environmental condition falls within pre-determined parameters suitable for blasting, the wireless detonator assembly otherwise maintaining a safe mode incapable of receiving and / or responding to a command signal to FIRE; and

a firing circuit (43) associated with the base charge,

characterized in that the firing circuit includes a charge storage device such that, upon receipt by the command signal receiving and processing module of a command signal to FIRE, the charge storage device can discharge a current in the firing circuit, the current being sufficient to actuate the base charge; and

in that the activation / deactivation module comprises discharge means to selectively bleed charge away from the charge storage device to render the wireless detonation assembly incapable of actuation when the at least one state sensor senses environmental conditions that fall outside said pre-determined parameters suitable for blasting.

2. The wireless detonator assembly of claim 1, wherein the command signal receiving and processing module (40) comprises an RF receiver.

3. The wireless detonator assembly of either claim 1 or 2, wherein the at least one state sensor (15) senses at least one environmental condition of the detonator

assembly, such that failure to detect an appropriate environmental condition is indicative of the absence of the wireless detonator assembly from, or improper placement of the wireless detonator at, the blast site.

4. The wireless detonator assembly of any one of claims 1 to 3, wherein the at least one state sensor (15) senses for at least one environmental condition that is normally associated with conditions down a borehole in rock to be blasted.

5. The wireless detonator assembly of any one of claims 1 to 4, wherein the at least one state sensor (15) is located within said detonator shell.

6. The wireless detonator assembly of any one of claims 1 to 5, further comprising a top-box remote from the detonator shell and associated components, to remain at or above ground-level when the wireless detonator assembly is placed at a blast site.

7. The wireless detonator assembly of any one of claims 1 to 6, further comprising a container or housing for containing or housing at least the components of the assembly other than the detonator, with a wired or wireless link between the other components and the detonator.

8. The wireless detonator assembly of any one of claims 1 to 7, wherein said activation / deactivation module further comprises a switch to open the firing circuit when said at least one state sensor senses that the at least one environmental conditions falls outside of said pre-determined parameters suitable for blasting, thereby to prevent actuation of the base charge even upon receipt by the command signal receiving and processing module of a command signal to FIRE.

9. The wireless detonator assembly of claim 1, wherein the charge storage device includes a capacitor.

10. The wireless detonator assembly of any one of claims 1 to 9, further comprising a clock to count down a deployment window, within which the at least one state sensor is inactive, or within which the wireless detonator is non-responsive to the at least one state sensor, after which the at least one state sensor (15) senses the at least one environmental condition in the immediate vicinity of the detonator assembly, and the detonator assembly is responsive to the at least one environmental condition.

11. The wireless detonator assembly of any one of claims 1 to 10, further comprising a clock to count-down a time-window for a blasting event, wherein the state sensors (15) are active to sense the at least one environmental condition of the immediate vicinity of the assembly only within said time-window.

12. The wireless detonator assembly of any one of claims 1 to 11, wherein each state sensor (15) senses at least one environmental condition selected from: temperature, light, motion, acceleration, vibration, humidity, density, and pressure.

13. The wireless detonator assembly of any one of claims 1 to 12, further comprising wireless signal transmission means, for transmitting to an associated blasting machine, hand-held device or logger, data corresponding to the environment condition in its immediate vicinity at the blast site.

14. A method of blasting rock pre-drilled with boreholes, the method comprising the steps of:

1) assigning to each borehole at least one wireless detonator assembly of any one of claims 1 to 13;

2) optionally using a hand-held device or logger to communicate with each assigned assembly to read data from and / or program data into each assembly;

3) connecting each assembly to an explosive material to form a primer;

4) placing each primer into the borehole;

5) loading explosive into each borehole;

6) optionally stemming each borehole;

7) transmitting wireless command signals to control and FIRE each detonator;

characterized in that at any time the method further comprises: sensing at least one environmental condition in an immediate vicinity of each wireless detonator assembly, whereby at any time one of the wireless detonator assemblies senses that the at least one environmental condition is or becomes outside of predetermined parameters for blasting, the discharge means of the respective wireless detonation assembly bleeds charge away from the charge storage device to render that assembly incapable of actuation.

15. A wireless electronic primer for use in connection with a blasting machine, said blasting machine controlling said wireless electronic primer via at least one wireless command signal, the wireless electronic primer comprising:

the wireless detonator assembly (10) of claim 1;

an explosive charge in operative association with said detonator (12), such that actuation of said base charge causes actuation of said explosive charge;

said command signal receiving and processing module (40) in signal communication with said detonator (12) such that upon receipt of a command signal to FIRE by said command signal receiving and processing module (40) said base charge and thus said explosive charge are actuated, providing said at least one state sensor senses environmental conditions that fall within pre-determined parameters suitable for blasting.