RTM - Reverse Time Migration
Reverse Time Migration

The several **Migration Algorithms** differentiate in terms of accuracy level with respect to the geological complexity of the areas under investigation.

RTM is the **most advanced algorithm** in the **Seismic Migration** toolbox, offering uncompromised accuracy (provided that the velocity model is also accurate enough).

Nonetheless before the advent of more powerful computers that made RTM feasible, seismic imaging was done with other algorithms, less accurate but also less demanding in terms of computing capacity.
Reverse Time Migration

One of the migrations most commonly applied before RTM was the so called **Kirchhoff Migration**. The trade-off accepted when using Kirchhoff is that *seismic wave propagation can be mathematically described by means of rays*, as it happens with light. Ray tracing algorithms are not very expensive (especially if compared to the power of today’s computers). On the other hand, ray theory was developed for Optics, starting from the assumption that the frequency of the propagating waves is extremely high (asymptotic assumption). The result is that rays are suitable to describe light propagation that consists of electromagnetic waves with frequencies in the order of the TeraHertz. With seismic waves the asymptotic assumption is weaker as their frequencies usually go from few Hertz to an upper limit that is rarely above 150-200 Hz.

The consequence is that in practice **Kirchhoff Migration is accurate when the velocity is nearly homogeneous**, whilst its accuracy significantly degrades in areas where there are strong velocity contrasts. For instance this happens in presence of salt bodies (or diapirs) as it is typical in Gulf of Mexico and offshore West Africa.
Reverse Time Migration

**RTM** overcomes Kirchhoff Migration limitations since it does not introduce any approximation in the Physics of seismic wave propagation. RTM is currently the tool of choice for **subsalt imaging**. However, it must be pointed out that RTM improved output quality comes at the price of an increased computational cost. Indeed RTM is also well known for being much more expansive than Kirchhoff migration (in the order of one to two orders of magnitude). With RTM parallel and scalable software implementation is unavoidable.

*Figure 1.* Rays vs. full wave propagation (as in RTM). Background image represents the velocity model.
Figura 2: Kirchhoff (left) versus RTM (right). Yellow circles and boxes highlight the areas where RTM imaging is superior to Kirchhoff. Background image represents velocity, salt is in red.